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United States
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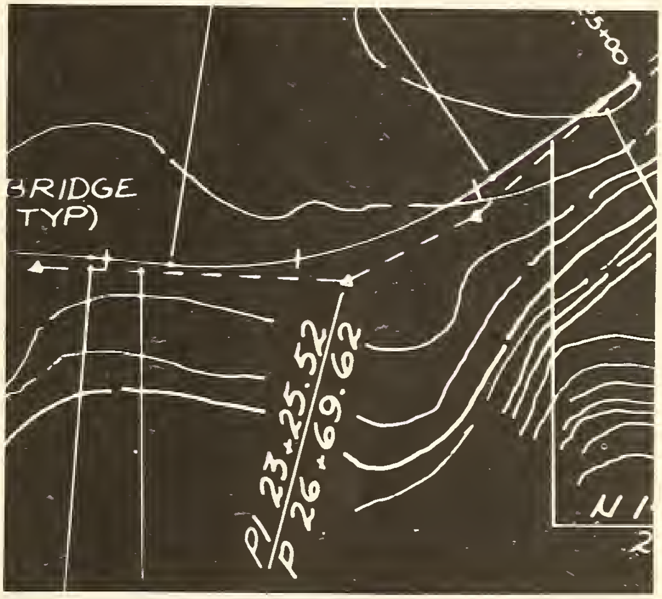
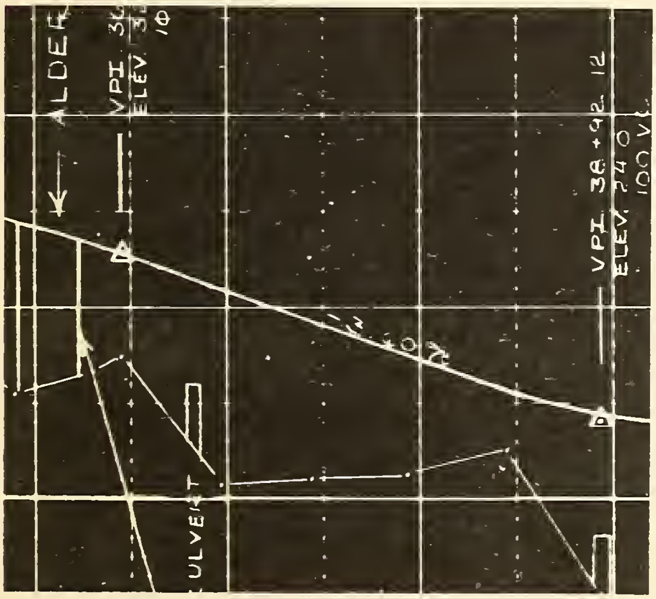
Forest Service

Alaska Region
Report 160

1981

Draft
Environmental Impact Statement: Road Access and Bulk Sampling at the U.S. Borax Quartz Hill Molybdenum Claims, Tongass National Forest, Alaska





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DRAFT ENVIRONMENTAL IMPACT STATEMENT
ROAD ACCESS AND BULK SAMPLING

U.S. Borax Molybdenum Claims at Quartz Hill
Tongass National Forest, Alaska

Alaska Region Report 160
November 1981

Lead Agency: USDA - Forest Service
Tongass National Forest
Federal Building, Department QH
Ketchikan, Alaska 99901

Responsible Official: J. S. Watson, Forest Supervisor, Ketchikan Area, Tongass National Forest.

For Further Information Contact: Edward R. Johnson, IDT Leader
Tongass National Forest
Federal Building
Ketchikan, Alaska 99901
(907) 225-3101

Technical Assistance Provided by: Dames & Moore, Anchorage

Abstract: The proposed action is issuance of a special use permit to U.S. Borax & Chemical Corporation to construct an access road and conduct bulk sampling activities at Quartz Hill under authority of the Alaska National Interest Lands Conservation Act (Public Law 96-487). The area lies within the boundaries of the Misty Fiords National Monument and is administered by the Forest Service, U.S. Department of Agriculture. Based on available information, Quartz Hill is one of the largest known molybdenum deposits in the world and could supply 18 percent of world molybdenum demand. Two alternative road routes and their supporting facilities are analyzed for impacts on water quality, fish, wildlife and their habitats, and National Monument and wilderness values.

Cooperating Agencies:

- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- Alaska Department of Fish and Game
- Alaska Department of Community and Regional Affairs
- Alaska Department of Natural Resources
- Southern Southeast Regional Aquaculture Association, Inc.
- U.S. Bureau of Mines
- City of Ketchikan and Ketchikan Gateway Borough
- Alaska Department of Commerce and Economic Development
- Alaska Department of Transportation and Public Facilities

Comments on this draft EIS must be postmarked by January 29, 1982. Mail all comments to the above address.

ERRATA

The following corrections should be made to "Road Access and Bulk Sampling at the U.S. Borax Quartz Hill Molybdenum Claims Draft Environmental Impact Statement". Report No. 160 and No. 160A, published by the U.S.D.A.- Forest Service.

Page	Correction
Inside Cover Both Reports	Responsible official should be R. Max Peterson, Chief, U.S. Forest Service
ii-TABLE OF CONTENTS	2.3.3. Should read "Bulk Sampling with Surface Access via the Blossom River".
5	ALTERNATIVES AND ENVIRONMENTAL EFFECTS- Should read: 1. No action -- Deny Permit 2. Permit Bulk Sampling and Access via the Blossom River Route. 3. Permit Bulk Sampling and Access via the Keta River Route.
2-2	Insert between first and second sentences at top of page - "Several marine terminal locations were examined for both alternatives. Because there was only one feasible terminus in each alternative, analysis of additional sites was not undertaken".
2-17	2.3.3. Should read "Bulk Sampling with Surface Access via the Blossom River".

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Washington Office
12th & Independence Ave. SW
P.O. Box 2417
Washington, DC 20013

1950
December 3, 1981

Dear Reviewer:

In the Alaska National Interest Lands Conservation Act (ANILCA) passed last year, Congress mandated that the Forest Service prepare an Environmental Impact Statement (EIS) on surface access and bulk sampling at the U.S. Borax molybdenum claims at Quartz Hill in Misty Fiords National Monument.

This draft EIS was prepared under the direction of an interdisciplinary team representing interested State, Federal, and local organizations. The Forest Service is the lead agency.

There is no preferred alternative. Because of the many uncertainties, public comments relating to the draft EIS are important to the identification of a preferred alternative to be displayed in the final EIS. These comments must be analyzed and considered prior to the selection. Public safety, fisheries, and wildlife values, as well as possible community locations and other factors, will be considered in the determination.

The purpose of this draft EIS is to insure that environmental information is available to public officials and citizens before decisions are made and to provide an opportunity to comment on the proposal. We look forward to receiving your comments and will consider those postmarked on or before January 29, 1982.

We anticipate publishing a final EIS and record of decision in March 1982. Please submit your comments directly to Supervisor Watson in Ketchikan.

Please note that an errata sheet has changed the responsible official from Forest Supervisor Watson to the Chief of the Forest Service. This was necessary in order to comply with Section 503(h)(4)(A) of ANILCA which requires the Secretary to complete any administrative review of my decision within 4 months. The normal review procedure, found in 36 CFR 211.19, would extend the appeal well beyond the specified 4-month period.

Sincerely,

/S/Douglas Leisz

R. MAX PETERSON
Chief

Enclosure

INSERTIONS

Page 9

There is no Forest Service preferred alternative. Because of the many uncertainties, public comments relating to the DEIS are important to the identificaton of a preferred alternative, and these comments must be analyzed and considered prior to selecting the preferred alternative to be displayed in the FEIS. Public safety, fisheries, and wildlife values, as well as possible community locations and other factors, will be considered in determining the preferred alternative.

Page 2-66(2.4)

There is no preferred alternative. Because of the many uncertainties, public comments relating to the DEIS are important to the identificaton of a preferred alternative, and these comments must be analyzed and considered prior to selecting the preferred alternative to be displayed in the FEIS. Public safety, fisheries, and wildlife values, as well as possible community locations and other factors, will be considered in determining the preferred alternative.

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Cover photos courtesy U.S. Borax & Chemical Corporation

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SUMMARY

INTRODUCTION

The Secretary of the U.S. Department of Agriculture was charged by the Alaska National Interest Lands Conservation Act (ANILCA) with responsibility to grant a special use permit for construction of "a surface access road for bulk sampling unless he shall determine construction or use of such a road would cause an unreasonable risk of significant irreparable damage to the habitats of viable populations of fish. . . ." U.S. Borax and Chemical Corporation (U.S. Borax), acting for its associate, the Pacific Coast Molybdenum Company, has applied for such a permit to extract and transport some 5,000 tons of molybdenite ore (the "bulk sample") from a massive quartz porphyry deposit at Quartz Hill located in southeastern Alaska some 45 air miles east of Ketchikan. This quantity of ore is required to permit adequate testing of process technology, metal recoverability, and tailings characteristics to permit design of the ore processing and tailings disposal systems. Major activities governed by the proposed action are:

1. Construction of marine terminal facilities including: barge ramp, marshalling area, fuel storage and containment area, and a moored stiffleg log boom.

2. Establishing a floating camp of modular living units at tidewater.

3. Construction of a nominal 4.2-meter (14-foot) wide gravel road from the marine facilities some 14 to 16 kilometers (9 to 10 miles) to the orebody.

4. Possible additions to the existing camp, adits, and road system on Quartz Hill.

5. Extraction, stockpiling, and transportation of the bulk ore samples.

6. Continued mineral exploration and facility site studies.

An interdisciplinary team (IDT) comprised of U.S. Forest Service and other State and Federal agency representatives was established to deal with issues related to the Quartz Hill development. The IDT participated in selection of a third party consultant, funded by U.S. Borax, to assist the Forest Service in preparation of this EIS. A public scoping meeting was held in Ketchikan in March 1981 from which a list of six major categories of issues relating to this EIS was derived:

1. Whether the road location is to be in the Blossom or Keta River valleys (Figure 1).

2. Impacts of construction on erosion and landslides, water quality and flow, aquatic organisms and habitat, and on wildlife.

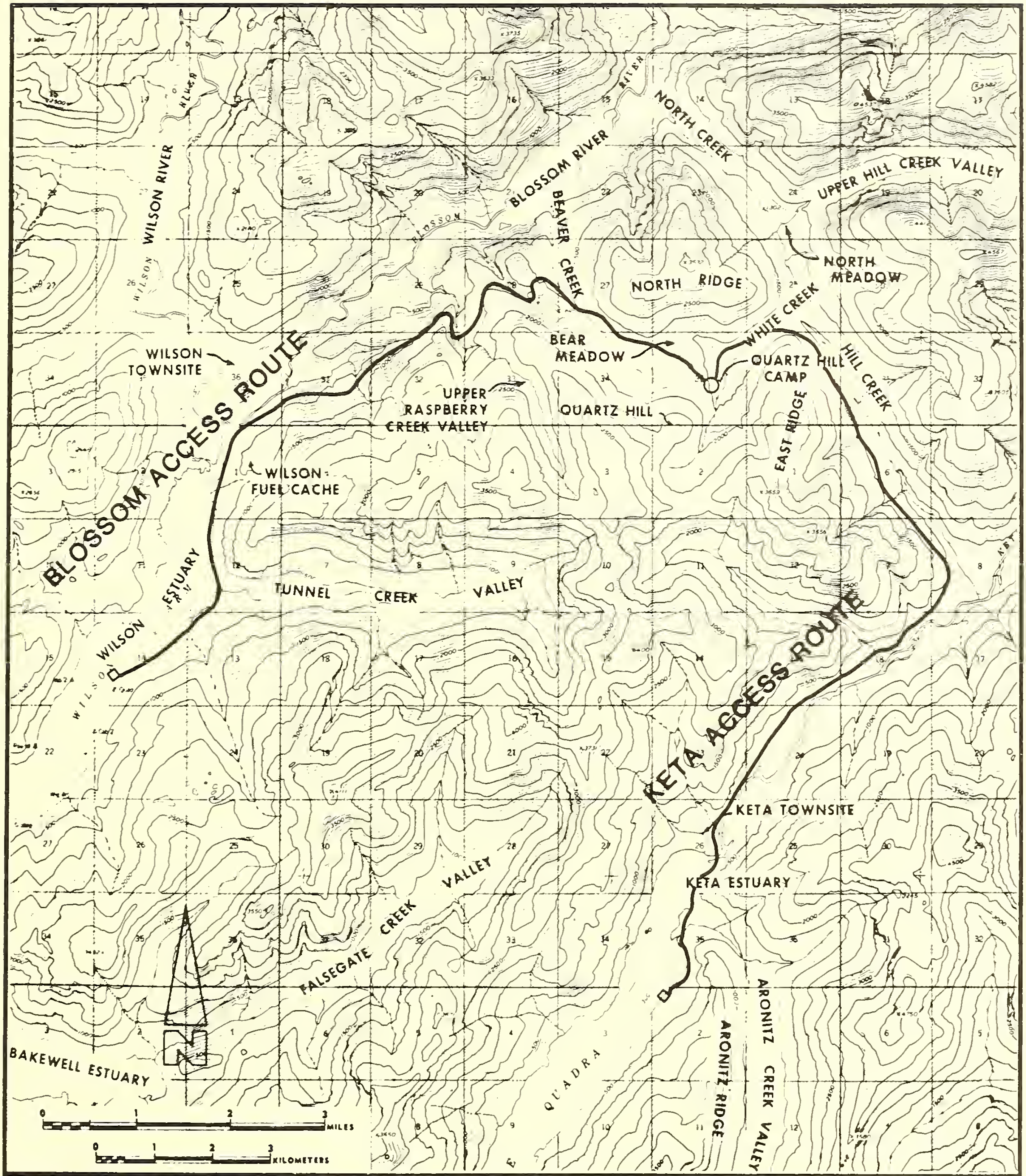
3. Degree to which impacts can be mitigated.

4. Implications of route selection on future mine facility locations including access road, wharf, town or campsite, and marine tailings disposal.

5. Conflict between the existing fishery and the future mining industry over the effects of road building and overall mine development on fish habitat.

6. Presence of the project within a National Monument and adjacent to a Wilderness area and the potential impacts on the purposes for which these classifications were established.

The Quartz Hill deposit is located within the Misty Fjords National Monument created by ANILCA. While the surrounding areas of the Monument are classified as Wilderness, a 60,300-hectare (149,000-acre) parcel including Quartz Hill and the heads of two fjords that offer the most reasonable access to the site were excluded from this designation to allow development of the mine.



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

QUARTZ HILL
ACCESS ROAD ALTERNATIVES

Figure 1

AFFECTED ENVIRONMENT

The environment of the region encompassing the Misty Fjords National Monument and the specific area of the Quartz Hill project is at present largely in its natural pristine state. The Monument lies in the maritime climatic zone of southeast Alaska. This zone is typified by cool summers, mild winters, and heavy precipitation. Steep forested mountainsides and shear rock cliffs rise abruptly from the depths of glacially-formed fjords. Two such fjords, Smeaton Bay/Wilson Arm and Boca de Quadra, provide the only practical surface access options to Quartz Hill, via the Wilson/Blossom and Keta Rivers, respectively.

Mountain tops in the area are generally rounded and support typical alpine flora and fauna. Several species of birds and mammals are locally abundant. Along the marine shorelines, the estuaries at the heads of the fjords and the major rivers, bald eagles and several waterfowl species are common.

Mountain goats, black and brown bears, wolves, and Sitka blacktail deer are important large mammals and many smaller furbearers are also present.

The Wilson River and its major tributary, the Blossom River, in the Wilson Arm drainage and the Keta River in the Boca de Quadra drainage are both clear-water river systems with excellent spawning and rearing habitat for anadromous salmonids. The Blossom, due to its very large pink salmon run, supports the greatest total number of the commercially and recreationally important salmon species although all three streams are of major significance.

The waters of the two fjords in the project area support abundant marine life. Dungeness crab and shrimp are harvested commercially in these fjords and several other species present are harvested commercially elsewhere in southeastern Alaska.

The Alaska Department of Fish and Game has concluded that overall biological resource values and wildlife habitat quality are higher in the Smeaton Bay drainage than in the Boca de Quadra. Human activities in the region have to date been largely limited to mineral prospecting, trapping, hunting, fishing, and sightseeing. The particular aesthetic qualities of the region have been recognized by its designation as National Monument in ANILCA.

U.S. Borax and several State and Federal agencies have gathered a substantial data base on existing meteorological, biological, geological, hydrological, oceanographic, and socioeconomic conditions affecting the road access and bulk sampling (the subject of this EIS) and the full mine development (to be covered in a subsequent EIS).

ALTERNATIVES AND ENVIRONMENTAL EFFECTS

Three primary alternatives were considered:

1. No action--deny permit.
2. Permit access via the proposed Blossom River route.
3. Permit access via the alternative Keta River route.

No Action

The no action alternative, i.e., the decision to deny the permit, could result in a decision by U.S. Borax not to pursue development of the orebody since they would likely not have adequate data for design of the processing and tailings disposal systems. The relatively minor economic benefits of the road construction and bulk sampling phase would be lost along with the substantially greater benefits of the mine development and operation phase. The several potentially adverse environmental effects of road construction, town or campsite construction and operation, marine tailings disposal, and loss of wilderness values that would stem from mine development would not occur.

Blossom River Access Option

Under this option, proposed by U.S. Borax, the marine terminal facilities and temporary worker housing would be located at the head of the Wilson Arm of Smeaton Bay. A road of some 15 kilometers (9-1/2 miles) long would be constructed along the east side of the fjord, crossing some 1,097 meters (1,200 yards) of tideflats of the Wilson estuary and then angling upward across steep side slopes into the Blossom River valley. The road would cross several tributaries of the Blossom River in this steep north-facing slope, eventually reaching Quartz Hill via the Beaver Creek valley.

The proposed project using this option would destroy or directly affect some 2.5 hectares (6.2 acres) of valuable estuarine marsh, 8.1 hectares (20.1 acres) of other wetlands, and 35 hectares (87 acres) of other upland habitats. An insignificant area of intertidal and subtidal habitat in the marine terminal facilities area would also be altered. A small distributary channel on the Wilson delta that is of some importance to rearing juvenile salmonids would be displaced. Significant disturbance of bald eagle nest sites, waterfowl nesting and resting areas, and large mammal movements are possible during construction of route segments near the Wilson estuary.

Construction-caused erosion and landslides have the potential of moving some 214,088 cubic meters (280,000 cubic yards) of earth downslope. Significant quantities of this material are likely to enter the Blossom River, reducing the quality of the aquatic habitat for spawning and rearing by anadromous salmonids. Qualitative evaluations of the magnitude of reduction in numbers of salmon fry produced in 1983 (from 1982 spawners) suggest that reductions would be difficult to detect in marine fisheries 1-1/2 to 5 years later because of compensatory mortality in later life history stages, natural variability in marine survival factors, and lack of information on contributions of individual streams to the fishery. Habitat degradation due to construction-caused sedimentation should be largely ameliorated within 1 to 2 years due to natural flushing of the stream during high water periods. Some long-term depression of spawning success could occur if stream substrates were permanently altered.

Construction of the required marine facilities and access road will have a short-term (less than 1-year) adverse impact on the existing primitive recreation values in the Wilson Arm area and on wilderness values in adjacent areas of the Monument. Visual impacts at the head of Wilson Arm will remain for many years. Impacts of these activities would be relatively minor, however, in comparison to those that would result from a subsequent decision to provide access to and worker housing for the entire mine operation via Wilson Arm, especially if a permanent town was constructed. Since this is currently among the more heavily used fjords and valleys in the Monument, conflicts in wilderness recreation opportunities would be great.

Keta River Access Option

Under this alternative, the marine terminal facilities and temporary worker housing would be located at the head of Boca de Quadra. A road of some 16 kilometers (10 miles) would be constructed along the east side of the fjord, crossing some 430 meters (470 yards) of tideflats of the delta. The road would ascend in the floodplain of Keta River for several kilometers, with some encroachment into the river channel required before angling upward across steep side slopes into the Hill Creek valley. The road would require major bridges across Aronitz Creek and the Keta River. It would cross several tributaries and major avalanche paths in the Hill Creek valley, eventually reaching Quartz Hill via the White Creek valley.

The proposed project using this option would destroy or directly affect some 1 hectare (2.4 acres) of valuable estuarine marsh, 11 hectares (26.6 acres) of other wetlands, and 33 hectares (81.7 acres) of other upland habitats. An insignificant area of intertidal and subtidal habitat in the marine terminal facilities area would also be altered. A small distributary channel on the Keta delta that is of minor importance to rearing juvenile salmonids would be displaced. Significant disturbance of bald eagle nest sites, waterfowl nesting and resting areas, and large mammal movements are possible during construction of route segments near the Keta estuary.

Construction-caused erosion and landslides have the potential of moving some 23,000 cubic meters (30,000 cubic yards) of earth downslope. Significant quantities of this material are likely to enter the Keta River, reducing the quality of the aquatic habitat for spawning and rearing by anadromous salmonids. Qualitative evaluations of the magnitude of reduction in numbers of salmon fry produced in 1983 (from 1982 spawners) suggest that reductions would be difficult to detect in marine fisheries 1-1/2 to 5 years later because of compensatory mortality in later life history stages, natural variability in marine survival factors, and lack of information on contributions of individual streams to the fishery. Habitat degradation due to construction-caused sedimentation should be largely ameliorated within 1 to 2 years due to natural flushing of the stream during high water periods. However, increased rates of river meandering downstream of areas where the road would encroach into the main river channel could negatively or positively affect productivity. Salmonid rearing habitat would be reduced by roadway encroachment.

Construction of the required marine facilities and access road would have a short-term (less than 1-year) adverse impact on the existing primitive recreation values in Boca de Quadra and on wilderness values in adjacent areas of the Monument. Visual impacts at the head of Boca de Quadra would remain for many years. Impacts of these activities would be relatively minor, however, in comparison to those that would result from a subsequent decision to provide access to and worker housing for the entire mine operation via the Keta River, especially if a permanent town were constructed. Since this is currently among the least used areas in the Monument, conflicts in wilderness recreation opportunities would be minor compared to those that might occur under the Wilson/Blossom access option.

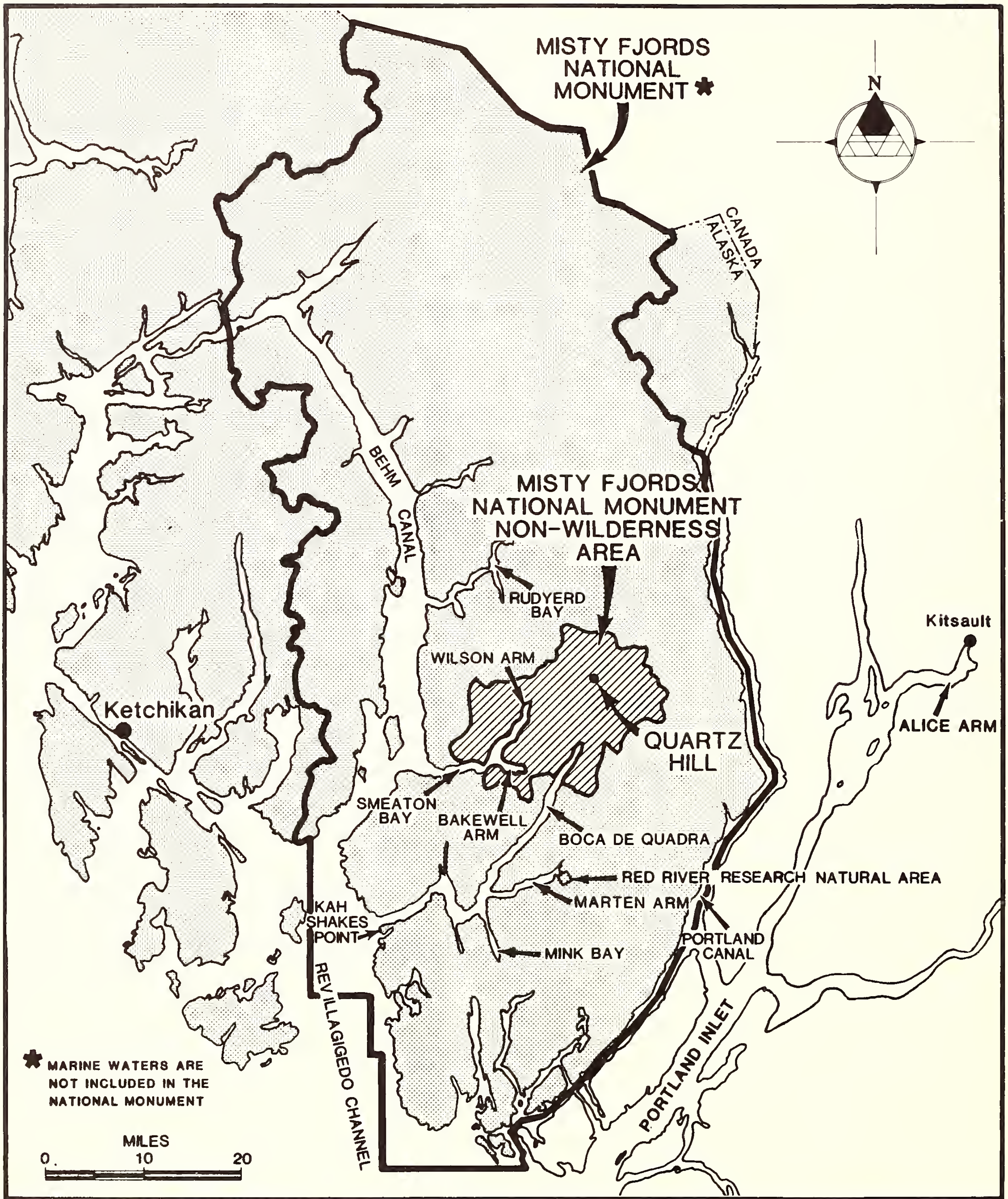
1.0 INTRODUCTION

1.1 HISTORICAL BACKGROUND

In 1974, United States Borax & Chemical Corporation (U.S. Borax) conducted a geochemical exploration program on Federal land in the First Judicial District of the State of Alaska. This program resulted in the discovery and acquisition (mining claims) of a molybdenum deposit. Molybdenum is a metal having a variety of industrial uses including steel alloys. At the time of the discovery, the area was part of the Tongass National Forest and was open to mineral entry and multiple use. U.S. Borax subsequently conveyed its interest in the claims to Pacific Coast Molybdenum Company, an associate corporation. Under a contractual agreement with Pacific Coast Molybdenum Company, U.S. Borax continues to manage exploration and development of the project (now designated the Quartz Hill Molybdenum Project; U.S. Borax 1981).

The mineral deposit is located on a knoll (named Quartz Hill) in an elevated valley in a mountainous region of southeast Alaska (Figure 1-1). It is situated on a large peninsula on the watershed line dividing the Blossom River and the Keta River drainage areas. The area lies in the Misty Fjords National Monument (Figure 1-1) and is administered by the Forest Service, United States Department of Agriculture, which is the lead agency for this action. The deposit does not lie in any designated Alaska city or borough. The nearest U.S. communities are Ketchikan Gateway Borough and the City of Ketchikan, which lie approximately 45 air-miles west of Quartz Hill.

Based on the information available through 1979, U.S. Borax (1981) has estimated that proven and probable mineable ore reserves total 1.5 billion tons of 0.14 percent molybdenite (molybdenum disulfide, MoS_2) average grade with a 0.07 percent MoS_2 cutoff grade. Given these statistics, Quartz Hill is one of the largest known molybdenum deposits in the world, holding perhaps 10 percent of the world's known mineable molybdenum reserves. At the currently envisioned concentrator feed rate of 60,000 tons per day and based on 1979 U.S. Bureau of Mines figures, the project could supply 18 percent of



* MARINE WATERS ARE NOT INCLUDED IN THE NATIONAL MONUMENT

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

QUARTZ HILL REGION MAP

Source: U.S. Forest Service

Figure 1-1

world molybdenum demand. Future drilling may expand these reserve estimates, as the deposit has not yet been fully identified laterally and at depth (U.S. Borax 1981).

The Quartz Hill molybdenum deposit can be mined by open-pit methods, has a low waste to ore stripping ratio, and is located only a few kilometers from tidewater (U.S. Borax 1981). However, the unique environmental setting and heavy precipitation, as well as the lack of existing community infrastructure at the site, constitute constraints to development and add extra costs. Preliminary analysis indicates that these problems can be overcome by using proper equipment and methods during the construction and operations phases of the project (U.S. Borax 1981).

A helicopter supported exploratory program has been in progress on the Quartz Hill molybdenum deposit intermittantly since 1974. Investigations have included geologic mapping, aerial topographic mapping, surface surveying, core drilling, collection of a few surface samples from pits, exploratory underground assessment and sampling, and environmental baseline data collection. Mineral exploration has consisted primarily of core drilling supplemented by the development of two adits (tunnel-like openings). Relatively small quantities of ore (less than 50 tons) have been removed from the site for analysis. Existing facilities at or near Quartz Hill include two 0.5-hectares (1.2-acre) rock work pads (adjacent to each adit), roadways connecting the adits to camp and to each other, and a 120-person camp constructed of wooden buildings. All work to date at Quartz Hill has been done under operating plans approved by the U.S. Forest Service.

In 1976, U.S. Borax applied to the Forest Service for a special use permit to construct a surface access road to the ore body. The purpose of the road was to allow extraction of a sufficient quantity of ore to verify the extent and quality of the deposit as well as to evaluate potential mining and milling processes, which is defined as the bulk sampling phase. An Environmental Impact Statement (EIS) was prepared by the Forest Service (U.S. Forest Service 1977) on this application. The 1977 EIS recommended that surface access be limited to a route in the Keta River drainage. This condition was attached to the special use permit granted by the Forest Service. Several private organizations appealed this decision on grounds that helicopter access was adequate and would remove the need for a roadway. The Undersecretary of Agriculture upheld the appellant's case and denied the permit on December 5, 1978. That same day the area was declared part of the Misty Fjords National Monument.

The proposed action, which is the subject of this EIS, is issuance by the Forest Service of a Special Use Permit to U.S. Borax and Chemical Company to conduct the following activities:

1. Construct a marine terminal and marshalling facility at tidewater in either Wilson Arm or Boca de Quadra.

2. Construct an access road (4.2-meter [14-foot] nominal width) from tidewater to the vicinity of the ore body via either the Wilson/Blossom or Keta River valley.

3. Excavate additional adits on site, construct necessary work pad, storage and maintenance facilities, stockpile some 46,000 tons of ore and waste rock on site and extract some 5,000 tons of ore to constitute the bulk sample.

4. Move the bulk sample by truck to the marshalling area and load it on a vessel for transport out of the state.

5. Continue exploration of valid mining claims in the area and conduct such studies and evaluations deemed necessary for mine design and planning as described in this document.

1.2 ANILCA AND THE EIS PURPOSE

The National Monument designation and provision for surface access to Quartz Hill became a part of the settlement of the "d-2" lands disposition by the Alaska National Interest Lands Conservation Act (ANILCA), Public Law

96-487. This act (hereafter referred to as "the Act"), which became law on December 2, 1980, retained the Misty Fjords area in National Monument status. The Act also placed all but 60,300 hectares (149,000 acres) of the area in wilderness classification. This non-wilderness Monument area (Figure 1-1), which includes the Quartz Hill claims, allows development of the mine and ore processing and support facilities.

The Act clearly spells out timetables and requirements for the development of two documents: the Mining Development Concepts Analysis Document (CAD; U.S. Forest Service 1981) and this environmental impact statement (EIS) for the surface access road and the bulk sampling phase.

The CAD was issued in draft form on June 2, 1981. Following revisions to incorporate responses to comments received, the final CAD was issued on September 2, 1981. Under the Act (Section 503[h][2]), the CAD included detailed discussions of, but was not necessarily limited to--

> "(A) the concepts which are under consideration for mine development;
>
> (B) the general foreseeable potential environmental impacts of each mine development concept and the studies which are likely to be needed to evaluate and otherwise address those impacts; and
>
> (C) the likely surface access needs and routes for each mine development concept."

The CAD was intended to aid in the understanding of the engineering, economic, social, and environmental implications of the concepts under consideration by U.S. Borax for development of the total mining project.

This understanding was required as background for the access road and bulk sampling EIS, which was required (Section 503[h][3]) to "include but not necessarily be limited to--

(A) an evaluation of alternative surface access routes which may minimize the overall impact on fisheries of both access for bulk sampling and mine development access;

(B) an evaluation of the impacts of the alternatives on fish, wildlife, and their habitats, and measures which may be instituted to avoid or minimize negative impacts and to enhance positive impacts;

(C) an evaluation of the extent to which the alternatives can be used for, and the likelihood of each alternative being used as a mine development road, including the impacts of widening a road, re-alignments and other design and placement options; and

(D) plans to evaluate the water quality and water quantity, fishery habitat, and other fishery values of the affected area, and to evaluate, to the maximum extent feasible and relevant, the sensitivity to environmental degradation from activities carried out under a plan of operations of the fishery habitat as it affects the various life stages of anadromous fish and other foodfish and their major food chain components."

The Act further requires that, within 4 months of publication of the final surface access and bulk sampling EIS, the Secretary of Agriculture must "complete any administrative review of a decision on the proposal covered by the EIS and shall issue to the applicant a special use permit for a surface access road for bulk sampling unless he shall determine construction or use of such a road would cause an unreasonable risk of significant irreparable damage to the habitats of viable populations of fish management indicator species and the continued productivity of such habitats."

Section 503(c) of the Act states that:

"Subject to valid existing rights and except as provided in this section, the National Forest Monuments (hereinafter in this section referred to as the "Monuments") shall be managed by the Secretary of

> Agriculture as units of the National Forest System to protect objects of ecological, cultural, geological, historical, prehistorical, and scientific interest."

Section 503(f)(2)(A) of the Act states that:

> ". . . any valid mining claim on public lands within the boundaries of the Monuments, shall be permitted to carry out activities related to the exercise of rights under such claim in accordance with reasonable regulations promulgated by the Secretary to assure that such activities are compatible to the maximum extent feasible, with the purposes for which the Monuments were established."

Therefore, ANILCA recognizes existing mining rights while, at the same time, requiring that activities be compatible with Monument purpose as much as possible. Maximum compatibility, as described above, as well as the protection of valid and existing rights served as the primary criteria upon which decisions have been based relative to the selection of preferred alternatives in the EIS. The primary alternatives evaluated in this EIS revolve around selection of either the Blossom or Keta River valleys for construction of marine facilities and access road as needed for bulk sampling. A prime concern also is that the surface access road be one that can be utilized in the eventual mine development phase (Congressional Record of August 19, 1980).

Additional relevant legal requirements are contained in the 1872 Mining Law which gives the prospector and miner the statutory right to enter the National Forests for the express purposes of prospecting and mining. This right cannot be unreasonably restricted. The 1897 Organic Act provides further that persons entering the National Forests for purposes of prospecting, locating and developing mineral resources under the 1872 Mining Law must comply with rules and regulations covering the National Forests.

These regulations require a notice of intent or a plan of operations if activities will disturb surface resources. Before approving these plans, the responsible Forest officer must evaluate the operation for conformance with the following: (1) applicable air quality standards; (2) applicable water quality standards; (3) applicable solid waste disposal standards; (4) scenic values; (5) protection of fisheries and wildlife habitat; (6) construction and maintainance of roads to minimize damage to soil and other values; and (7) adequacy of reclamation plans. Thus, the Forest Service is faced with a multiple task: to make minerals from National Forest lands, including National Monuments as provided by ANILCA, available and, at the same time, to minimize the adverse impacts of mining activities on the renewable and non-renewable forest resources.

1.3 SCOPING AND PUBLIC INVOLVEMENT

As required by the National Environmental Policy Act (NEPA) as amended, the Forest Service held a public scoping meeting in Ketchikan on March 18, 1981. Subsequently, the Inter-Disciplinary Team (IDT), comprised of Forest Service and other State and Federal agency personnel, discussed the issues, concerns, and comments brought forth in the public meeting, combined them with independently developed issues identified by the IDT and U.S. Borax, and published a preliminary composite list that was circulated to about 500 organizations, groups and individuals for comments. Concerned organizations, groups and individuals were invited to visit the appropriate Forest Service official to present or discuss issues. A final list of issues was published (Appendix A). Several major categories of issues relate directly to this EIS. The majority of these focus on:

1. The road location; whether the Blossom or Keta route would be selected.

2. The impacts of road and marine facility construction on slope stability, erosion and landslide potential, water quality and flow, aquatic organisms and their habitat and terrestrial wildlife.

3. The degree to which the above impacts can and will be mitigated.

4. The implications of route selection on future mine developments including the mine access road, wharf, town or campsite, and marine tailings disposal location.

5. The conflict between the existing fishery and the future mining industry over the effects of road building and overall mine development on fish habitat.

6. The occurrence of the project within a National Monument and adjacent to a wilderness area and the potential impacts on the purposes for which these classifications were established.

Within each of these major categories are many subcategories or topics, which are addressed in the appropriate sections of this EIS. Broader issues of mine development impact will be dealt with in the total project EIS if a decision is made to proceed to full mine development.

1.4 STATUS OF LICENSES, PERMITS AND APPROVALS

The current status of the proposed action in relation to major legislative and regulatory actions governing its implementation is summarized in Table 1-1. Many permits, approvals, and policy compliance reviews other than those listed would be necessary before and during construction under State and local statutes and regulations. In addition, other agencies have policy implementation responsibilities that could relate to the proposed action. Those items that could have a major impact on the current progress of the project have been listed in Table 1-1.

The U.S. Army Corps of Engineers permit program has special applicability to the proposed activities. The Corps of Engineers is responsible for administering various Federal laws that regulate certain types of activities in waters in the United States and the oceans. The authorities for these programs are based on Sections 9 and 10 of the River and Harbor Act of 1899 (33 U.S.C. 401 et. seq.) and Section 404 of the Clean Water Act (formerly known as the Federal Water Pollution Control Act; 33 U.S.C. 1344).

TABLE 1-1

STATUS OF MAJOR LICENSES, PERMITS, AND POLICY COMPLIANCE

Statute or Regulation	Administering Agency	Status
Alaska National Interest Land Conservation Act	U.S. Department of Agriculture	Special use permit shall be issued within 4 months of FEIS unless road is determined to cause unreasonable "significant irreparable damage" to important fish habitat.
Clean Water Act/Section 404; River and Harbor Act/ Section 10	Corps of Engineers	Permit applications made September 15, 1981; in review.
Endangered Species Act; Fish and Wildlife Coordination Act	Fish and Wildlife Service; National Marine Fisheries Service	The Fish and Wildlife Service and National Marine Fisheries Service are both cooperating agencies in this EIS; coordination with FWS and NMFS is required.
National Pollutant Discharge Elimination System (NPDES)	Environmental Protection Agency	Agency concerns under subject regulations will be addressed. NPDES permit may not be required for access road construction and bulk sampling phase.
Coastal Zone Management Act	Office of the Governor/ Office of Coastal Management	Review State and Federal Actions for consistency with the Alaska Coastal Management Program standards and guidelines.
State 401 Water Quality Certification	Alaska Department of Environmental Conservation	Currently being reviewed.
Tide and Submerged Lands Leasing	Alaska Department of Natural Resources	Application for a tidelands lease submitted September 15, 1981, for work on the Wilson or Keta tidelands.

Mining activities carried out for the bulk sampling and construction of the access road and related structures which occur on wetlands or require discharge of dredged or fill material in waters or wetlands fall under Section 404 regulation or Sections 9 and 10, and will be carried out under one of several permit systems.

Many of the activities requiring a Section 404 permit will be conducted under the nationwide permit system. Permitted activities and prescribed management practices applicable to this permit are published in 33 C.F.R. 323.4, 323.4-2, and 323.4-3. For activities not included, U.S. Borax will be required to obtain an individual or general Section 404 permit.

Permit will also be required under Section 10 of the River and Harbor Act of 1899 (33 U.S.C. 403) for all structures or work in or affecting navigable waters of the United States (see 49 C.F.R. 1.46(c)).

2.0 ALTERNATIVES

This chapter is intended to provide a concise discussion of the alternatives with respect to the proposed action along with their advantages and disadvantages. Chapter 2 should be considered the central chapter of this EIS. The more detailed environmental discussions occurring in Chapters 3 and 4 should be viewed as supporting material to the Chapter 2 analysis and conclusions.

2.1 FORMULATION PROCESS

Historical development of the Quartz Hill Project and the mandate of ANILCA have essentially dictated the range of alternatives to be considered in this EIS. ANILCA states that the EIS shall evaluate alternative surface access routes. The mine site is fixed by the location of the ore body and access options are severely limited by topography. The bulk sampling process itself is straightforward with no major alternatives that would significantly alter environmental impacts.

The Forest Service in considering the above facts has selected the reasonable alternatives to be considered in this analysis.

2.2 ALTERNATIVES ELIMINATED FROM CONSIDERATION

A number of alternatives were considered in the 1977 EIS that are not considered in this document. For instance, a helicopter supported operation without road access to tidewater was eliminated because ANILCA makes it clear that "surface access" is synonomous with access road (ANILCA Sec. 503 [h][3] and [h][4][A]). Similarly tramways, tunnels, cable cars and other transportation modes were discarded.

Reasonable access routes from tidewater to the mine site are limited by topography to the two general routes described in the following sections. Other access routes have been eliminated as being unreasonable from the standpoint of engineering aspects, environmental aspects, or both.

Within each of the two major access route alternatives, an array of options exists. The corridors selected for primary consideration by U.S. Borax will be the center of subsequent discussions. Options that appear to be worthy of discussion or have a particular advantage will be discussed along with the primary corridor. Options that offer no advantage over the primary corridor will not be addressed.

2.3 ALTERNATIVES UNDER CONSIDERATION

2.3.1 The No Action Alternative

ANILCA (Sec. [h][4][A]) indicates that a permit for the surface access road for bulk sampling will be issued unless the construction or use of the road ". . . would cause an unreasonable risk of significant irreparable damage to the habitats of viable populations of fish management indicator species and the continued productivity of such habitats." Therefore, the Forest Service cannot reject the proposed action unless conditions so warrant.

The no action alternative would mean that no road would be built by U.S. Borax, that future exploration activity by U.S. Borax would probably cease, and that existing exploration equipment and facilities owned by U.S. Borax would probably be removed from the project area.

2.3.1.1 Economic Impact Summary

The alternative of not constructing the access road and not conducting the proposed bulk sampling activities would have both local and national/international economic impacts.

Direct local impacts would be relatively minor and would include the loss of approximately 100 potential new jobs for the 1- to 2-year construction period, a portion of which would be filled by local workers; loss of the potential income to Ketchikan businesses related to services and supplies such as air charter services, groceries, that other supplies for access road construction and bulk sampling phase; and loss of income related to transportation and entertainment services that would be sought by off-shift workers in Ketchikan.

Indirectly, failure to construct the access road and conduct the bulk sampling activities would likely result in a decision by U.S. Borax not to pursue mine development, which would result in a loss of approximately 860 potential jobs over the 70-year economic life span of the mine. This point was discussed in the concepts analysis document (CAD) and will be addressed in more detail in the EIS for the total project.

The most significant adverse impacts of the no action alternative relate to the national and international effects of failure to pursue mine development. As noted in the CAD, benefits of mine development would include providing a substantial contribution to the expansion of the mineral extraction industry in southeast Alaska, thus providing further economic diversity and reducing dependence on the lumber and fishing industries. Additionally, increasing the U.S. production of molybdenum would assure a more steady domestic supply of an essential mineral resource. Increasing the geographic diversity of molybdenum production would protect against stoppages in supply due to natural disasters, mine shutdowns, or other reasons and contribute to a more favorable balance of payments through sales of molybdenum to other nations.

2.3.1.2 Environmental Impact Summary

If the bulk sampling and future mine development phases were prohibited from proceeding, exploration activities at Quartz Hill would presumably cease and U.S. Borax would be required to rehabilitate existing disturbed areas. None of the impacts to the physical and biological environment described in the remaining sections of this chapter or in Chapter 4 would occur and the area would essentially regain its wilderness character. Some development scars would remain in the orebody vicinity for an indefinite time period but would become less conspicuous with the passage of time.

Not developing the Quartz Hill molybdenum deposit could create a need for molybdenum mines at other locations. The extent of this need would depend on worldwide conditions of supply and demand. If substitute mines were developed, environmental impacts of unknown, but significant, magnitude would occur at some other location(s). Whether or not the impacts would be greater than or less than those that would occur at Quartz Hill cannot be determined.

2.3.2 Activities That Would Occur Regardless of Access Route

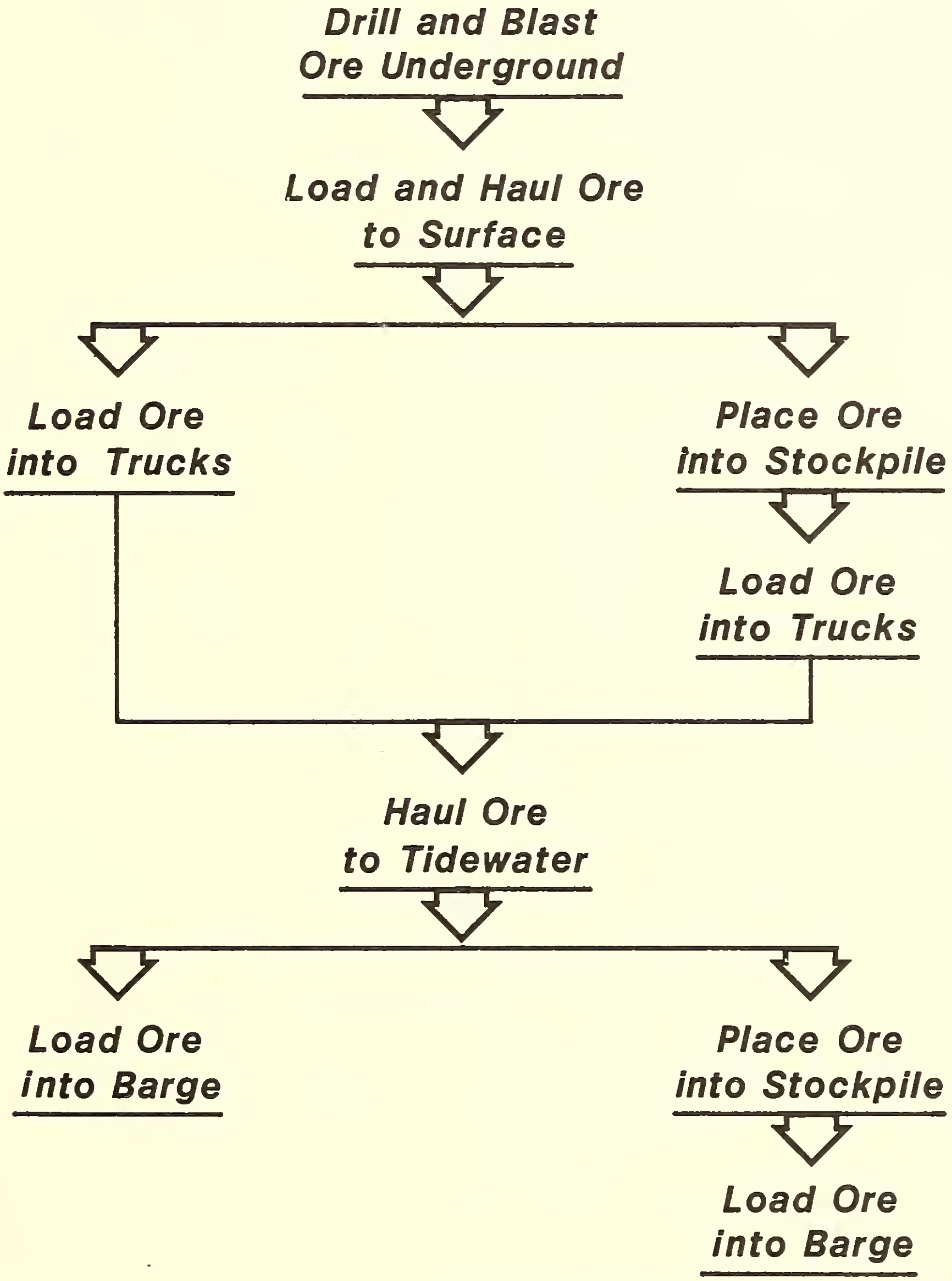
2.3.2.1. Overview of the Bulk Sampling Process

The bulk sampling phase is an extension of the exploration that has occurred to date. Environment assessment reports (E.A.R.) have been prepared on these previous activities. The types of activities assessed in these reports include deep hole drilling, excavation of adits, construction of work areas and buildings, road survey, preparation and removal of ore samples, seismic testing, and construction of road between adits and camp on the claims. The environmental effects of these activities are disclosed in the E.A.R. approved by the Forest Supervisor on April 17, 1981 and are incorporated here by reference (U.S. Forest Service 1981b). It is planned to remove a minimum of 5,000 tons of ore from various selected areas underground in the existing and planned adits (tunnel-like openings), and transport the ore from Quartz Hill to a metallurgical pilot plant facility located outside Alaska. The plan for handling this ore is as follows (Figure 2-1):

- Drill and blast the ore underground from selected sites along the length of the adits.

- Load the ore underground using LHD (load-haul-dump) equipment and haul to the surface, loading directly into trucks or dumping into a stockpile adjacent to the portals.

- If ore is stockpiled, then a skiploader would be used to load the ore into trucks.



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

FLOWSHEET FOR HANDLING ORE OF BULK SAMPLING PHASE

Figure 2-1

- Trucks would haul the ore from the stockpile to tidewater, dumping directly into a barge or into a stockpile adjacent to the dock area.

- Ore placed in a dock area stockpile would then be loaded from the stockpile into a barge.

Trucks with a capacity of 10 to 15 tons would be used to move approximately 5,000 tons of ore from the adit portals to tidewater. On this basis, 335 to 500 truck trips would be required using 10 trucks. The movement of 5,000 tons of ore is estimated to take 7 to 10 days.

In addition to the bulk sampling proper, this EIS also addresses other subsurface exploration activities that would occur concurrent with or subsequent to bulk sampling but prior to the mine development phase that will be addressed in a future EIS. This exploration work would involve metallurgical testing of relatively small volume ore samples and would be similar to the kinds of ore sampling that has occurred to date. See Section 2.3.2.4 for additional explanation.

2.3.2.2 Need for Bulk Sampling

The Quartz Hill orebody consists of a number of different molybdenite bearing rock types. Each of these rock types has different characteristics, such as grindability, flotation characteristics, and grade. In order to define the appropriate metallurgical process and recovery of molybdenite (MoS_2), each rock type must be tested separately, with a continuous pilot plant run over an extended time period of 20 to 40 days. During this pilot plant run, the grinding time, amount of reagents, water, and flotation time would also be varied. Assays of the concentrate produced would be made to check on recovery and the concentrate grade. After the individual rock types are tested, a composite sample, consisting of a sample with different percentages of the different rock types that will be mined, would be blended together and processed continuously by the pilot plant at the rate of 2 to 4 tons per hour over 3 to 4 months.

This metallurgical phase of predevelopment evaluation requires the transportation of bulk rock, selectively separated from adit walls, to the pilot mill in quantities sufficient to permit testing under controlled circumstances of a variety of processes. This procedure is critical to the design, feasibility determination, and environmental impact analysis of the milling and processing facilities required for the recovery of molybdenite from the ore.

Information that would be determined includes: suitability of the ore for processing, mineral recovery, best processing methodology, milling costs, plant design, energy requirements, water requirements, effluent water quality, nature of tailings, and kinds of treatment that may be necessary.

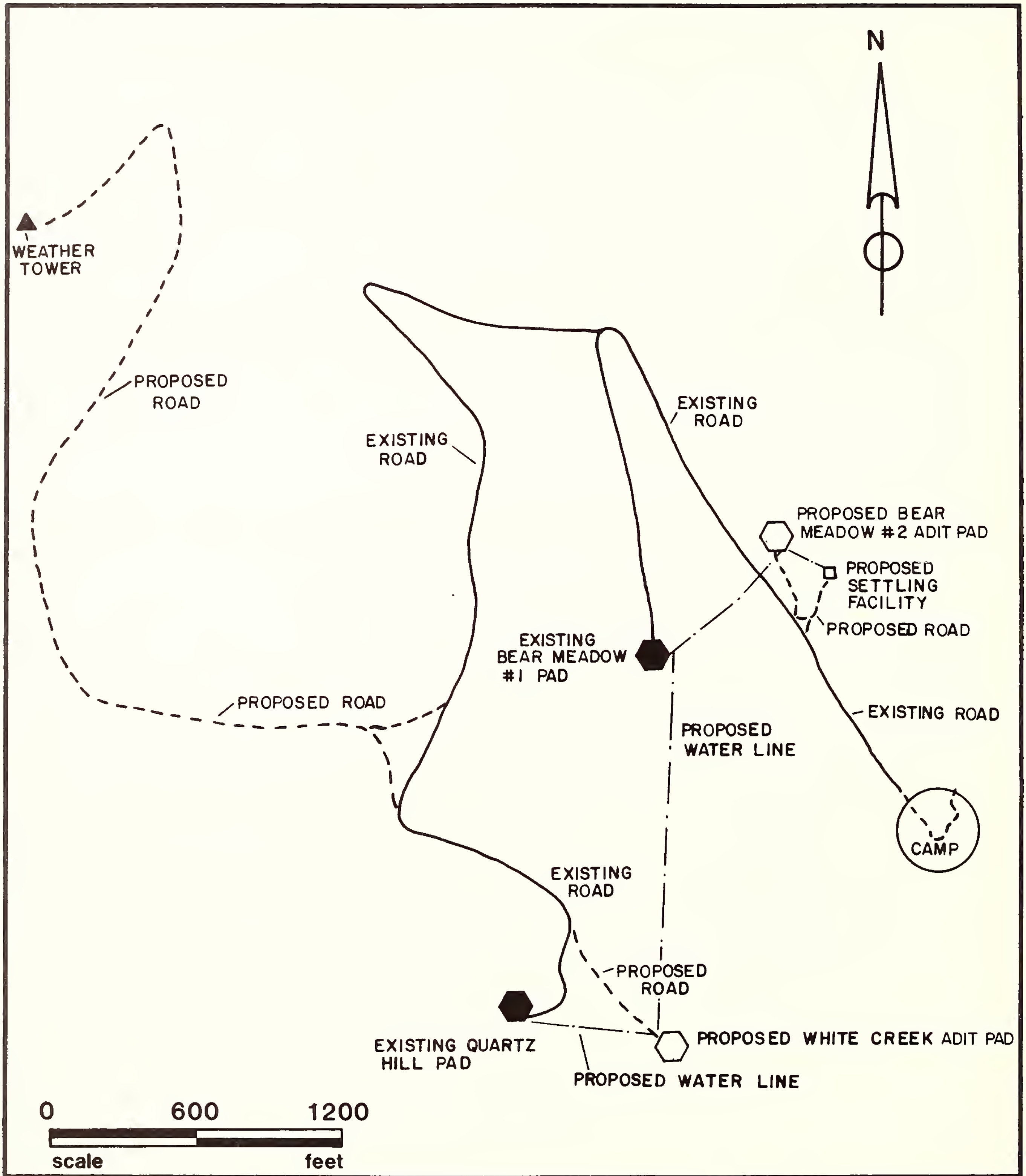
Bulk sampling cannot be accomplished by use of rock blasted at the face of the tunnel, as in the current exploratory operation, since such a process creates a disproportionately large quantity of small particles and lacks the selectivity of sampling required for such purposes. It also cannot be accomplished with rock crushed at the site; an essential condition for metallurgical testing from bulk samples requires the crushing to be accomplished in a variety of mill circuits.

The amount of unbroken ore necessary for the bulk sampling operation has been estimated at about 5,000 tons or more; the quantity must be sufficient to operate all process unit operations together, continuously and over an extended period of time. Depending on results obtained in early phases of the bulk sampling phase, a complete and adequate testing program for design development might require even more tonnage.

2.3.2.3 Surface Development and Facilities

In order to accomplish the proposed bulk sampling and other exploration activities, a variety of facilities would be required in addition to those already present.

Adit Surface Excavation and Facilities - Two new adits (tunnel-like openings) would be constructed (Figure 2-2). Pad excavation and surface



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

SURFACE FACILITIES

Source: U.S. Borax

Figure 2-2

facilities would be similar for each adit. It is estimated that approximately 4,000 cubic meters (5,000 cubic yards) of excavation would be required to construct an adit pad about 30 x 60 meters (100 x 200 feet). A typical adit pad would have the following surface facilities (Figure 2-3):

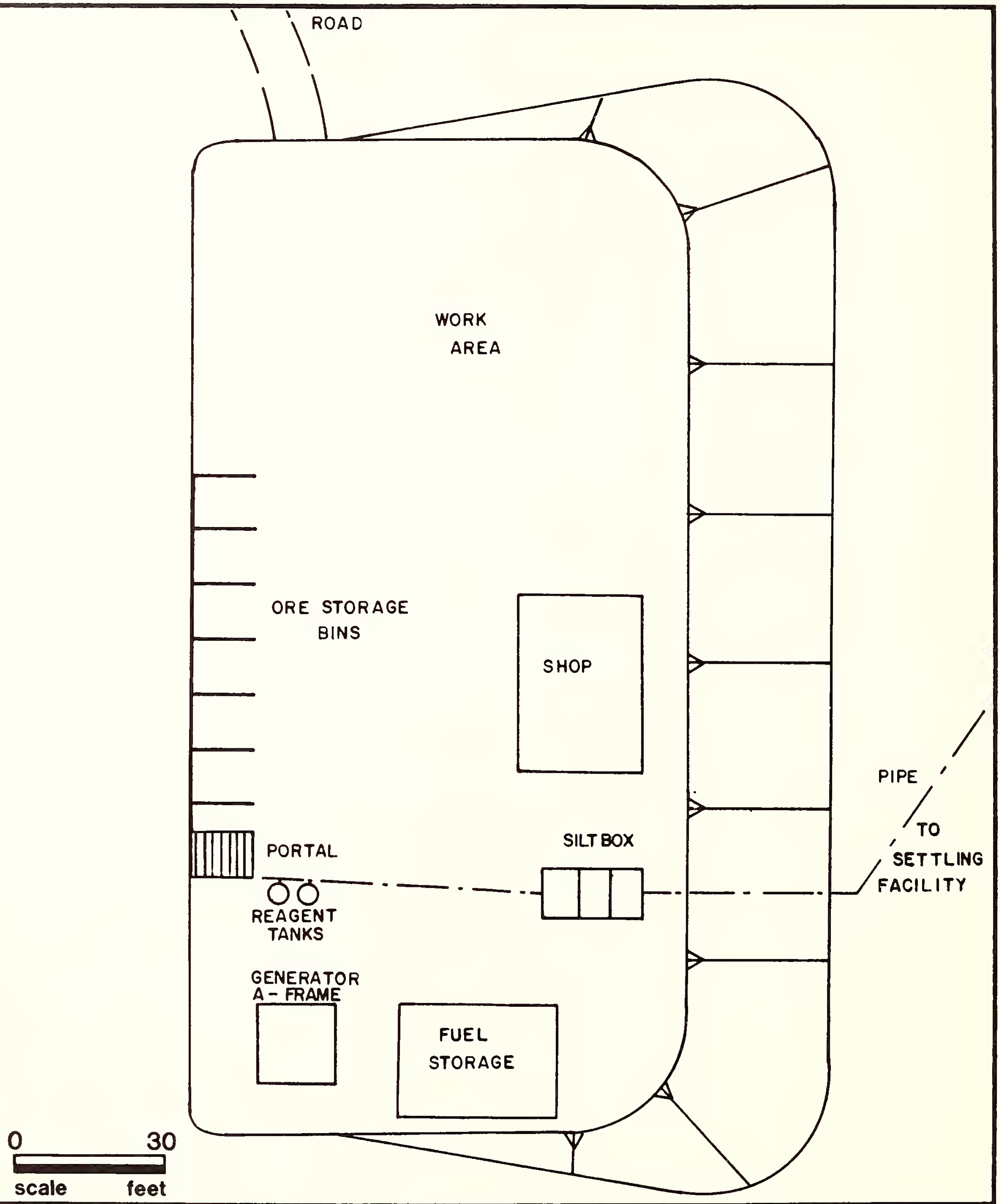
- A small "A" frame type building to house a generator set.
- An "A" frame building for a mechanical repair shop, lunch room, and loft for storage.
- Fuel storage for 45,400 liters (12,000 gallons).
- Ore storage bins (6).
- Silt box with reagent tanks.

Water Treatment Facilities - Water flow from each adit would be treated with reagents (aluminum sulfate and Seperan) to aid settling prior to entering the silt box (Figure 2-4). The water discharge or silt box overflow from the adits would be piped to a settling pond constructed below Bear Meadow Adit No. 2 (Figure 2-2). The pipeline would be PVC pipe, laid on the surface and anchored as necessary. It is estimated that 1,200 linear meters (4,000 linear feet) of pipe would be placed. The settling pond would have a capacity for a flow of 1,140 liters (300 gallons) per minute with a detention time of 6 hours. Surface water from the adit pads would be collected and treated with the adit discharge. Water from the settling pond would be discharged by a 15-centimeter (6-inch) perforated pipe on the surface of the ground below the pond. Silt boxes would be cleaned as required and silt disposed of in an approved manner.

Roads - The road system connecting the Quartz Hill facilities would be expanded with the construction of up to an additional 2,400 meters (7,800 feet). All roads would be nominally 4.2 meters (14 feet) wide and built to U.S. Forest Service specifications (see Section 2.3.2.4). A work pad would be constructed at Quartz Hill camp as shown on Figure 2-5.

Additional roads would be required for the following areas:

Quartz Hill Camp Area	- 305 meters (1,00 feet)
Bear Meadow Adit No. 2	- 107 meters (350 feet)

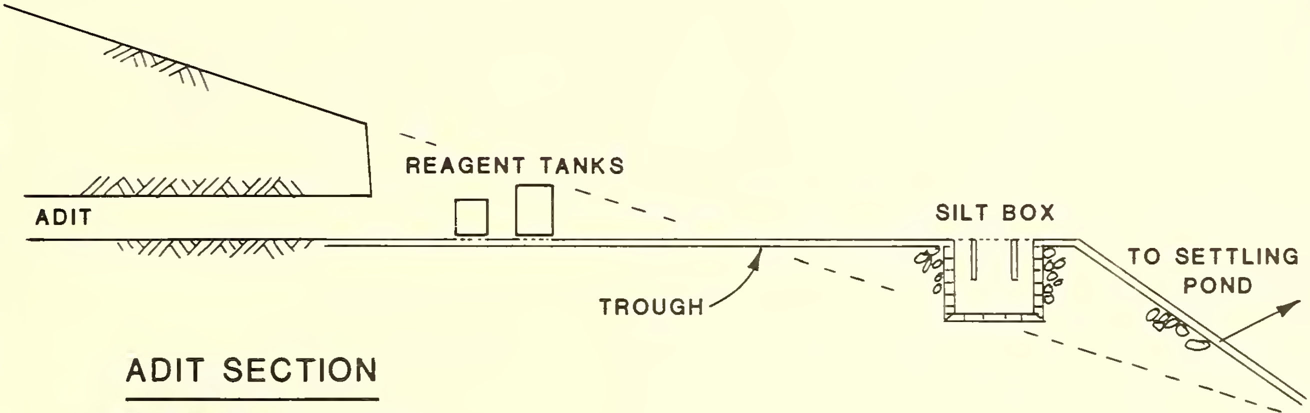


QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

TYPICAL PAD LAYOUT

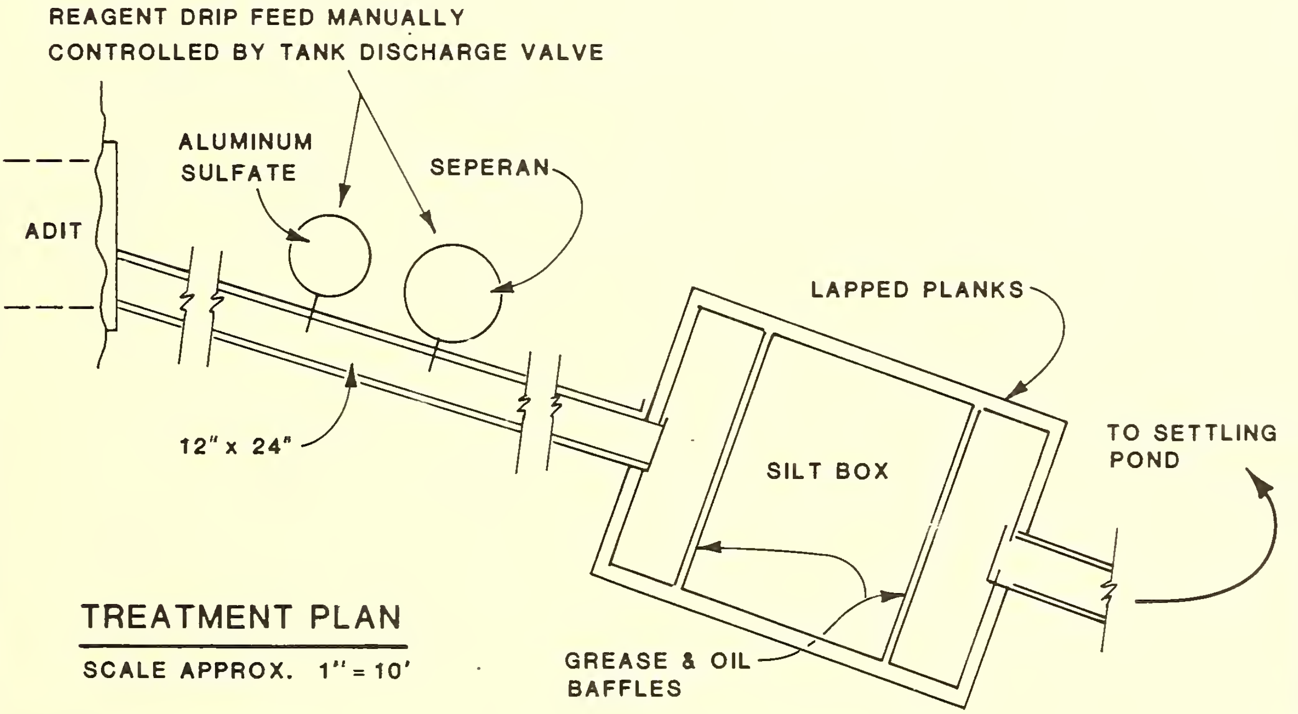
Source: U.S. Borax

Figure 2-3



ADIT SECTION

SCALE APPROX. 1" = 30'



TREATMENT PLAN

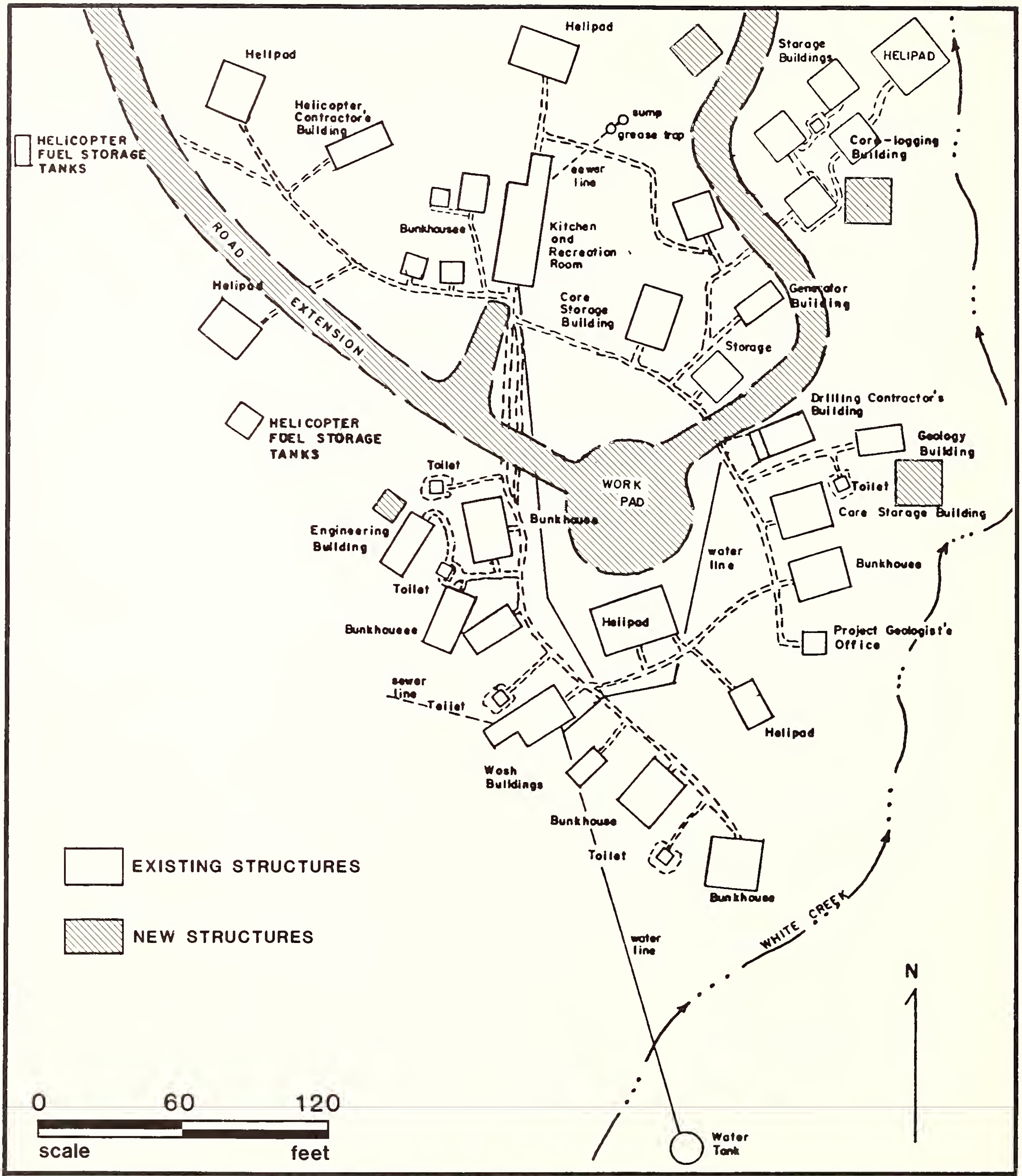
SCALE APPROX. 1" = 10'

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

ADIT DRAINAGE
WATER TREATMENT FACILITIES

Source: U.S. Borax

Figure 2-4



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

CAMP LAYOUT WITH NEW DEVELOPMENTS

Source: U.S. Borax

Figure 2-5

White Creek Adit No. 2 - 137 meters (450 feet)
Settling Pond - 91 meters (300 feet)
Weather Tower (tentative - 1,737 meters (5,700 feet)

Waste material would be disposed of in an approved disposal site, necessary culverts would be installed, and disturbed areas would be graded and seeded where required.

Camp - The existing project camp would be expanded with an estimated four additional "A" frame type buildings to be used to store drill core, samples, equipment and materials (Figure 2-5).

2.3.2.4 Underground Development

Underground mine workings, including the adits and connecting shafts in various directions, would be driven into the Quartz Hill ore body to obtain ore samples and map ore distribution. The underground openings would be either 2.1 x 2.4 meters (7 x 8 feet) or 1.8 x 1.8 meters (6 x 6 feet). Samples would be used either for bulk sampling or for other metallurgical testing such as assaying, grinding and flotation.

Quartz Hill Adit No. 1 - Development of this adit is underway. It is estimated that an additional 320 meters (1,050 feet) of shaft would be required, producing 3,900 tons of excavated material.

White Creek Adit No. 1 - This new adit would require about 914 meters (3,000 feet) of shaft and produce about 16,900 tons of excavated material. The need for this adit has not been firmly established and development might not occur.

Bear Meadow Adit No. 1 - Development of this adit is underway. It is estimated that an additional 790 meters (2,600 feet) of shaft would be required, producing 11,600 tons of excavated material.

Bear Meadow Adit No. 2 - This new adit would require an estimated 1,100 meters (3,600 feet) of underground opening and produce about 16,900 tons of excavated material.

Total estimated underground development footage is 3,125 meters (10,250 feet). Total excavated material is estimated at 46,300 tons. This tonnage would be sampled in the crushing plant currently located at Bear Meadow Adit No. 1. In addition to the bulk sample, up to 50 pounds of crushed sample for each meter of advance would be taken off site. All sampling plant rejects would be placed at the Bear Meadow Adit No. 1 pad which would, therefore, be the primary rock waste disposal area. The crushed samples to be taken off site, estimated at 256 tons, would be removed in suitable containers depending on sample size.

In addition to the bulk sample and the crushed samples, 1,000 tons of rock would be obtained by "slabbing" from underground areas containing specific rock types. These samples would be taken off site without processing. Up to an equal tonnage of waste from the slabbing operations would be placed on the pad of the adit or adits from which the samples were removed.

Other underground work such as excavation for drill stations, storage areas, shelter holes and "raise stubs" would involve the removal of additional waste rock. Up to 7,200 tons of waste could be produced. This material would be placed on the pad of the adit where the work occurred.

2.3.2.5 Site and Materials Evaluations

A systematic evaluation of facility sites for suitability and an evaluation of materials (soil, gravel, rock and clay) for construction use would be conducted in the project area.

The evaluation would include the following construction, engineering and geologic methods:

- Geologic and geotechnical mapping
- Geophysical surveys (seismic)
- Drilling (core, auger, rotary)
- Test pits (hand and machine)
- Trenching (hand and machine)
- Topographical and location surveys

Areas to be evaluated are shown on Figure 2-6 and include the following:

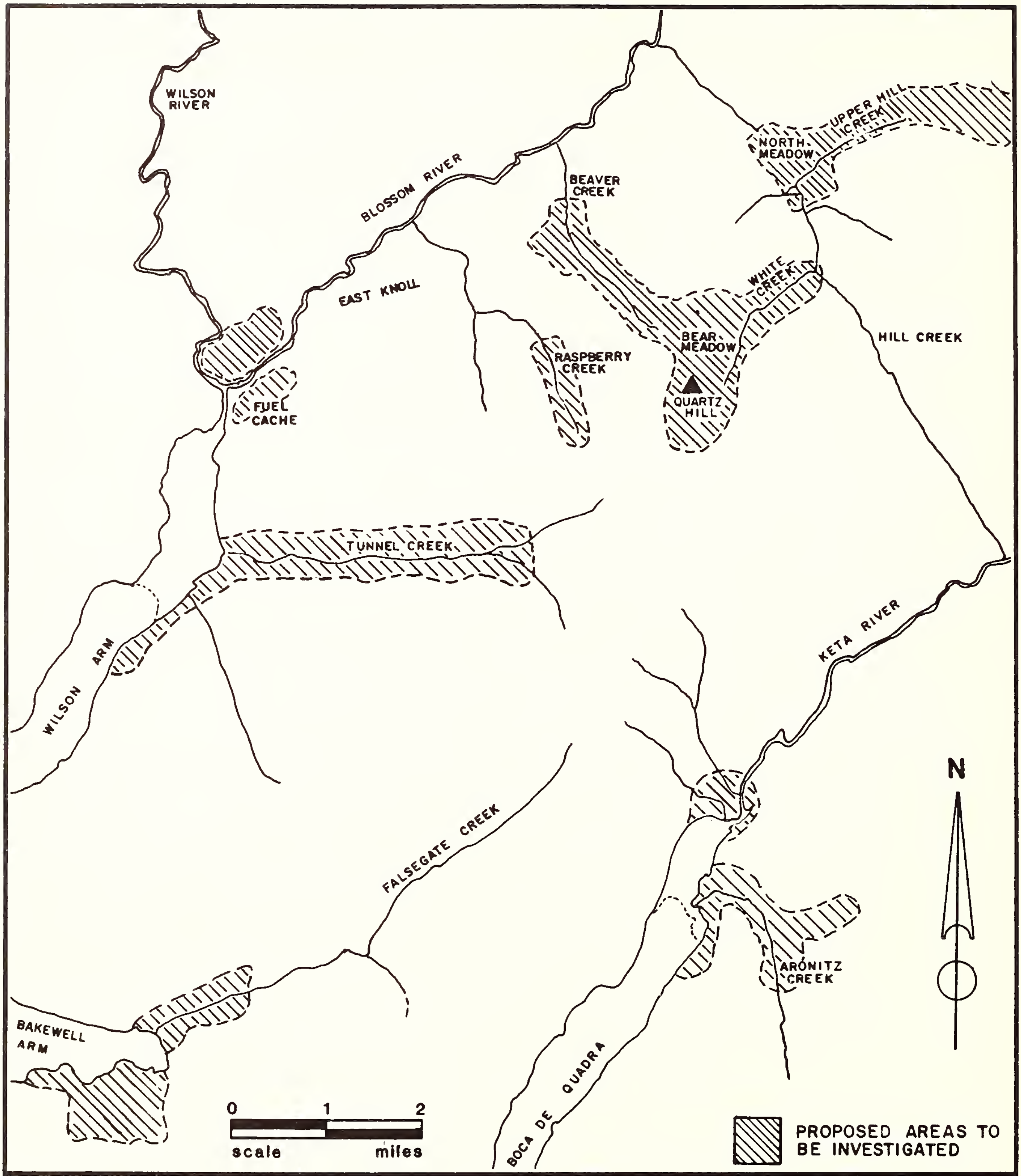
- Quartz Hill pit area
- White Creek
- Hill Creek
- North Meadow
- Upper Hill Creek
- Raspberry Creek
- Tunnel Creek
- Falsegate Creek
- Bakewell Arm townsite and nearby areas
- Wilson townsite
- Fuel Cache area
- Keta River townsite area
- Aronitz Creek area

All areas disturbed by drilling, test pits, and trenching would be cleaned up after data and information is obtained by filling in pits and trenches, and seeding where required.

Access would be by helicopter except where the areas are adjacent to the existing or proposed road systems.

2.3.2.6 Timing and Duration of Activities

It is the intent that this EIS address those activities described herein that would occur during and subsequent to the bulk sampling phase, but prior to initiation of total mine development. Actual schedules for specific work elements would depend on a number of variables including access alternative chosen, timing of permit acquisition, and proposed schedule for the subsequent mine development phase. The preferred schedule would be to initiate access road and marine facility construction (see Sections 2.3.3 and 2.3.4 for detailed discussion of these facilities) in the spring of 1982 and complete these facilities in the fall of 1982. Collection of bulk sample ore would occur concurrent with the access road work and ore transport would be



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

SITE AND MATERIALS INVESTIGATIONS

Source: U.S. Borax

Figure 2-6

conducted as soon as the road could be completed. Depending on the access route and/or construction start date, it might not be possible to complete the road in one season. In that case, the overall schedule would be delayed by one year with bulk sample transport occurring in the summer or fall of 1983. The other underground exploration activities, as well as the site and materials evaluations, would occur during the 1982 and 1983 field seasons. A decreased level of exploration and maintenance activity would probably occur in subsequent years until mine development could be initiated. The length of this interim period cannot be determined at this time.

The full requirements for continued evaluation of the orebody during the 1982 season will be known only after technical review of the information produced during the 1981 program. This review will be done during the winter of 1981-82. Some of the field work proposed for 1982-83, therefore, is included on a contingency basis and will be done only if the need is demonstrated.

Among the work items proposed, which at this time appear unlikely, are the following:

- Underground storage areas excavation (1,100 tons)
- White Creek No. 1 adit development (13,900 tons)
- Road to weather tower
- Two of the four camp buildings

2.3.3 Surface Access via the Blossom River

2.3.3.1 Marine Facilities

In order to support road construction activities and the subsequent loading of bulk sample ore onto barges, a variety of tidewater improvements would be required on Wilson Arm including:

- A barge ramp
- A marshalling area
- A fuel storage and containment area
- A permanently moored stiffleg log boom (string of logs connected by cable) to aid in booming and rafting operations.

The proposed layout for these facilities on Wilson Arm is presented in Figures 2-7, 2-8 and 2-9. Precise locations could vary somewhat pending final design. Total surface area of the marshalling area, barge ramp, fuel storage area, and associated cut slopes would be 1.2 to 1.6 hectares (3 to 4 acres). Because of the shoreline configuration, the marshalling area would have to be partly cut (benched) into the mountainside using standard drilling and blasting techniques. Shot rock from the marshalling area would be used as fill for the barge ramp and for the mine access road.

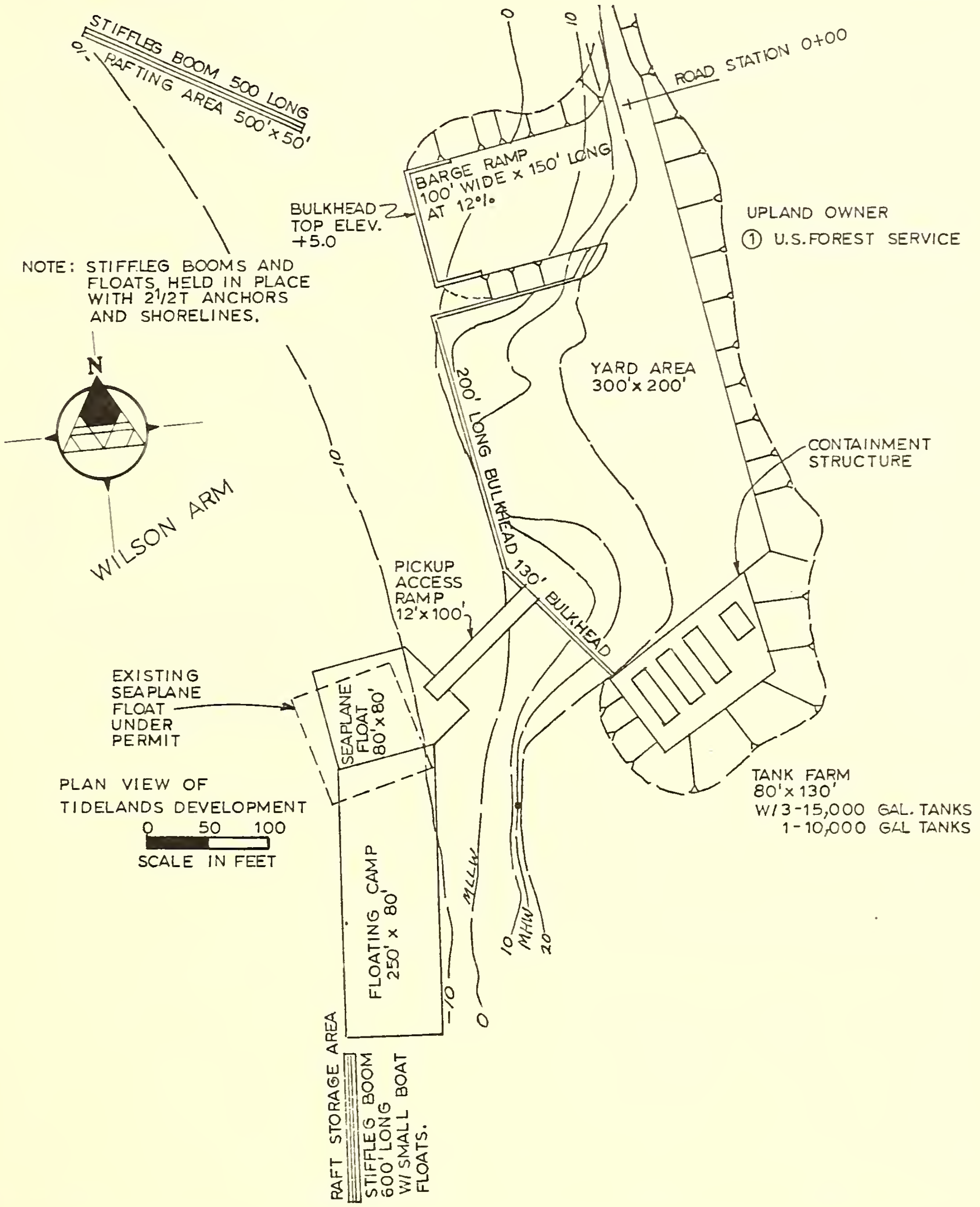
In addition to the above facilities, a storage building would be constructed on the staging area after completion of the bulk sample to be used for storing and handling supplies after the road contractor leaves.

Under ideal circumstances, construction of marine facilities would be initiated in spring of 1982 and completed in the summer, concurrent with access road construction.

2.3.3.2 Camp and Support Facilities

During access road construction and bulk sampling activities, a direct work force of about 100 persons would be employed. This work force would be housed partly in the existing Quartz Hill camp and partly in a 75-person floating camp to be moored in Wilson Arm adjacent to the marshalling area (Figure 2-7). A ramp would connect the floating camp to the marshalling area. The floating camp would consist of modular living units mounted on a barge or log float. A raft for docking float planes and boats would be integrated with or adjacent to the floating camp.

Domestic liquid wastes at the floating camp would receive treatment using a self-contained treatment unit mounted on the floating camp.

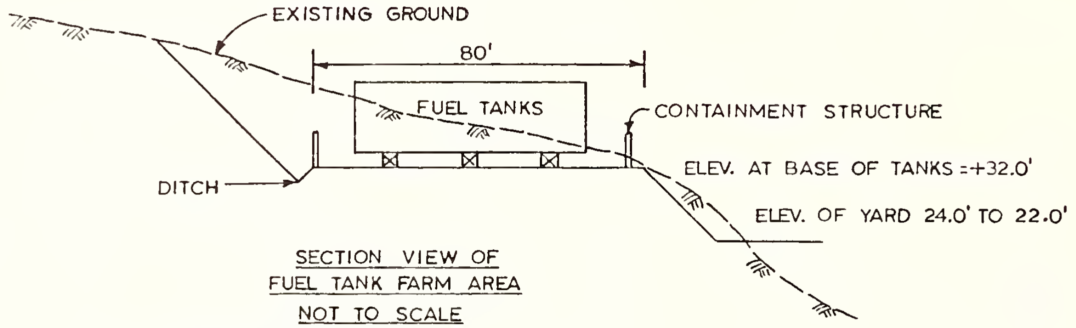


QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

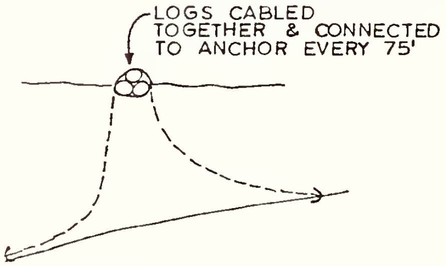
MARINE FACILITIES
BLOSSOM RIVER ACCESS

Source: Charles Pool & Assoc., Inc.

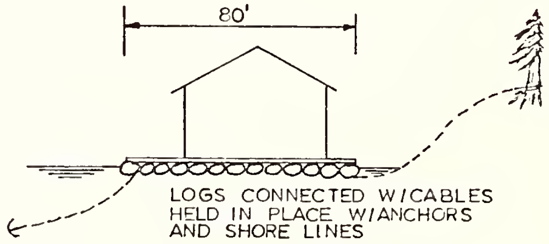
Figure 2-7



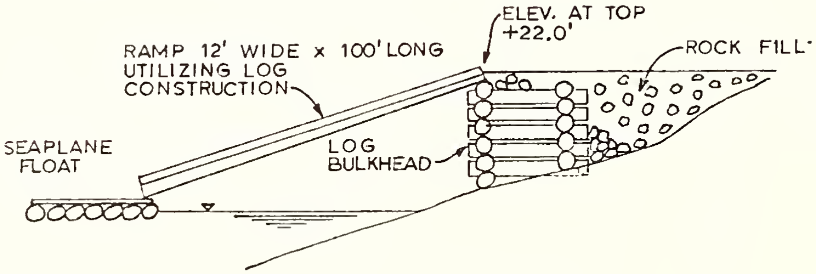
SECTION VIEW OF FUEL TANK FARM AREA
NOT TO SCALE



STIFFLEG BOOM DETAILS
NOT TO SCALE


80'
LOGS CONNECTED W/CABLES HELD IN PLACE W/ANCHORS AND SHORE LINES

FLOATING CAMP DETAILS
NOT TO SCALE



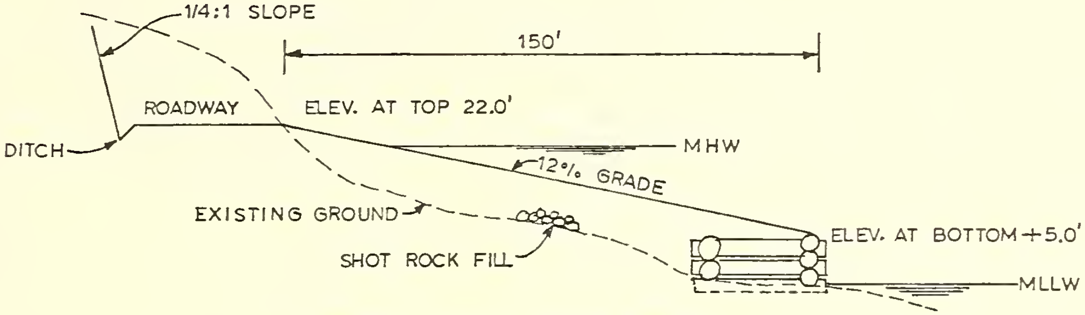
PICKUP ACCESS RAMP
NOT TO SCALE

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

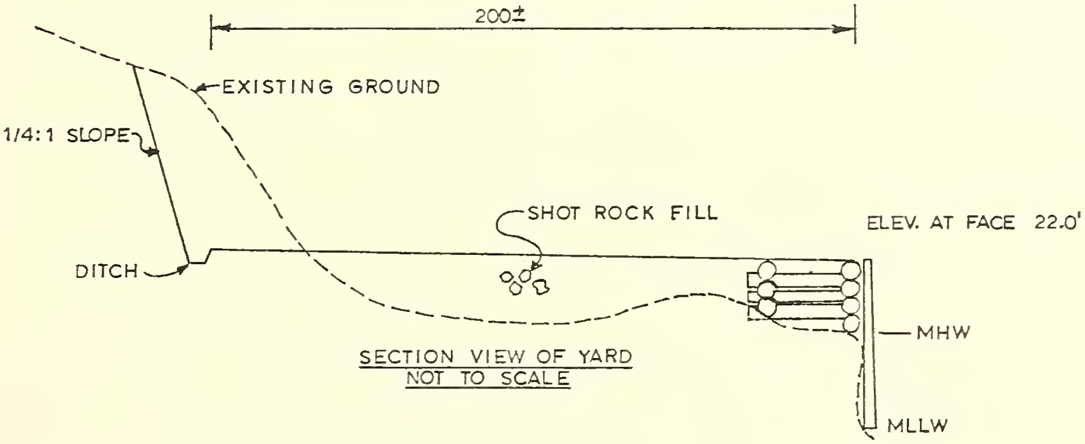
MARINE FACILITIES
SECTION VIEWS
BLOSSOM RIVER ACCESS

Source: Charles Pool & Assoc., Inc.

Figure 2-8



SECTION VIEW OF BARGE RAMP
NOT TO SCALE



SECTION VIEW OF YARD
NOT TO SCALE

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

MARINE FACILITIES
SECTION VIEWS
BLOSSOM RIVER ACCESS

Source: Charles Pool & Assoc., Inc.

Figure 2-9

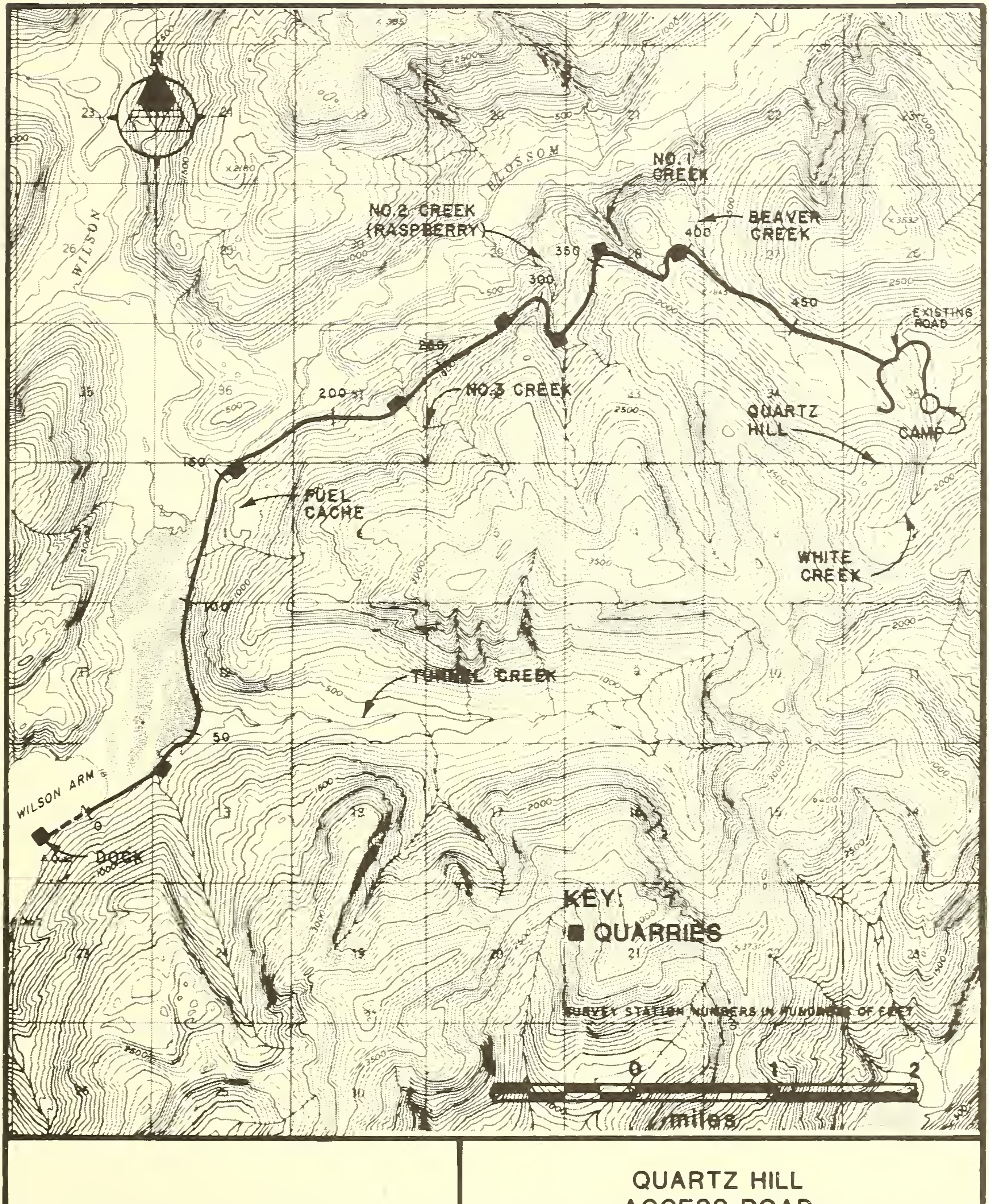
Discharge would be into the water of Wilson Arm. Effluent would conform with State and Federal standards and the terms of the discharge permit. Solid waste disposal would involve a combination of incineration and placement in an approved land fill. Potable (drinking) water would be obtained from the nearest suitable stream via a gravity pipeline and treated to the extent necessary to meet standards. It is possible that additional floating camp facilities could be brought to the area by individual construction contractors. These facilities might not conform to the standards described above.

2.3.3.3 Access Road

Appendix B provides a detailed description of the road corridor, geotechnical conditions and constructibility.

Design and Construction - The bulk sample access road would be designed to the standard of a 10-mile-per-hour low volume logging road as normally constructed in the Tongass National Forest. The gravel driving surface would be a nominal 4.2 meters (14 feet) wide with no shoulder in most areas. Extra roadway width might be required in areas of precipitous slopes for safety purposes. Additional areas with expanded width would be provided at intervals to serve as vehicle turnouts. The slope of the road embankment would be maintained as steep as possible, probably about 1.25:1. Fill depth would vary widely depending on terrain and soil features. In forested terrain, trees would be cleared for a distance of 6 to 18 meters (20 to 60 feet) on either side of the cut or toe of the fill depending on slope and other terrain features. Total cleared width including the roadway itself would average about 21 meters (70 feet). Additional trees outside this zone would be cleared if they posed a danger to the construction activities. "Danger trees" would be marked by the Forest Service in advance of construction.

Fill material would be derived from shot rock blasted from portions of the road corridor, from the proposed marshalling area, and from quarries located along the route. Numerous (8 to 10) quarries adjacent to the roadway would be required. Quarry location and size have not been established, but preliminary locations for some of the quarries are indicated on Figure 2-10. Where side slopes are greater than 40 percent, the road would



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

QUARTZ HILL
ACCESS ROAD
BLOSSOM ROUTE

Figure 2-10

have to be cut into the bedrock slope using blasting. About 25 percent of the Blossom River access route would require full bench cut slope construction with up to 40 percent requiring some rock excavation.

Handling of spoil materials such as organic surface soils would depend on terrain and soil characteristics. On steep terrain it might not be practical to strip surface soils prior to blasting. In overlay areas surface soils would be covered with shot rock fill. Where thick deposits of unstable soils have to be removed or in steep areas where possible, end-hauling spoil to an approved disposal site would be conducted.

Bridge crossings would be constructed from native timber or temporary steel bridges. Smaller streams would be crossed with culverts. Drainage structures on fish streams would conform to standards developed by the Alaska Department of Fish and Game and U.S. Forest Service (U.S. Forest Service 1979).

Additional facilities associated with the roadway would include a shop area and building located in the first available rock quarry and an explosives magazine located in a rock quarry or other approved location.

Route Description - The Blossom road alternative (Figure 2-10) begins at the marine facilities site on the southeast side of Wilson Arm near its head and runs along the eastern side of the arm and the Wilson/Blossom River tidelands for several miles. It then gradually ascends the steep eastern side of the Blossom River valley, crossing several tributary creeks. It enters the upper valley of Beaver Creek about 12 to 13 kilometers (7-1/2 to 8 miles) from the marine facilities and then continues southwestward along the Beaver Creek valley for about 3.2 additional kilometers (2 miles) to the mine site. The total length of the access road would be about 15.2 kilometers (9.4 miles).

The bulk sampling road would be constructed within the approximate alignment corridor of the proposed mine development road. Not only would this procedure minimize ultimate environmental disruption, but it would also allow the bulk sampling road to serve as the initial access route for construction of the mine development road.

There are three general terrain elements along the bulk sampling road route. These have been described as "the wharf and tidelands segment," "the sidehill segment," and "the Beaver Creek segment" (Appendix B). The wharf and tidelands segment is slightly over 3.2 kilometers (2 miles) in length; construction of the roadway would require nearly 0.8 kilometer (1/2 mile) of rock excavation. The alignment would cross two branches of Tunnel Creek, a large stream, and a smaller unnamed creek that flows into the tideland area between Tunnel Creek and the marine facilities site. Temporary bridges with estimated lengths of 18 meters (60 feet) for the unnamed creek, 18 meters or more for the major channel of Tunnel Creek, and about 15 meters (50 feet) for the minor branch of Tunnel Creek would be needed. Another small creek near the start of the segment would require a temporary bridge on the order of 12 meters (40 feet) in length. About 1 kilometer (0.7 mile) of this segment would involve overlay construction at the edge of the tideflats area.

The sidehill segment extends from the point where the alignment leaves the Wilson Arm tideflats along the steep to very steep southeastern side of the Blossom River valley to the crossing of No. 1 Creek, a distance of about 8 kilometers (5 miles). Crossings of No. 1 Creek, No. 2 Creek (Raspberry Creek), No. 3 Creek, and a number of unnamed streams would be required. Preliminary plans envision a total of seven temporary bridges in lengths ranging from 6 to 18 meters (20 to 60 feet). Much of this segment, probably at least three-quarters, would involve construction on steep to precipitous cross slopes including many rock cliff areas. Landslides of soil over rock could be induced or abetted by construction activities. Soils along this route are shallow (average less than 60 centimeters [24 inches]) and soil particles lack cohesion. In many areas with steep terrain, greater than 68 percent gradient, the soils exceed their internal angle of friction and, when disturbed, can break away and slide. A minimum of seven areas have been identified along this route that have a potential for sliding (Figure 4-1). Up to 36 hectares (90 acres) could be altered as a result of landslides.

The Beaver Creek segment extends from the crossing of No. 1 Creek across a saddle in the low ridge separating the No. 1 Creek and Beaver Creek drainages and continues along the valley of Beaver Creek to the Quartz Hill camp, a distance of about 3.2 kilometers (2 miles). This segment is characterized by gentle to moderately sloping terrain. Roughly two-thirds of it is expected to have muskeg deposits at the surface and some of these could be quite thick. A temporary bridge, estimated at 3 meters (10 feet) in length, would be required to cross Beaver Creek. Generally, there is low potential for landsliding along this segment. However, some slides could occur in the steeper slope areas along the western side of the Beaver Creek valley.

Construction Schedule and Sequence - If all approvals are granted, U.S. Borax would initiate road construction at the beginning of the 1982 construction season with plans to complete the road by October of 1982. Completing the road in one season would entail an intensive construction effort. Permit constraints could limit summer construction activities in the vicinity of eagle nests (see Section 2.3.3.4), potentially interfering with the above schedule. The Alaska Department of Fish and Game has placed restrictions on construction timing for parts of the proposed road to protect fish resources; instream work in Tunnel Creek would only be permitted during the period April 1 to July 1. Work would proceed 24 hours per day from at least seven separate "headings" or construction locations located as follows:

1. From the marshalling area working toward Quartz Hill. Equipment transported via Wilson Arm.
2. From the head of the tidal area at about Station 120+00. Work would proceed in both directions. Equipment would be transported by log float at high tide.
3. From about the middle of the road near No. 3 Creek. Work would proceed in both directions. Equipment would be airlifted to the site.
4. From the flat area at about Station 390+00. Work would proceed in both directions. Equipment would be airlifted.

Road Use - Immediately following completion of the access road, use would be intensive for a period of about 2 weeks during transport of the bulk sample by truck from Quartz Hill to tidewater. Road use would close at the end of the 1982 field season but would resume in the spring of 1983. Light to moderate road traffic would be required to support the 1983 program of mineral exploration and other investigations. Camp supplies, fuel and drill samples would be transported between Quartz Hill and the marine facilities. In the years subsequent to 1983 but prior to initiation of mine development, light road use would be expected to continue during the summer field season in order to support maintenance efforts and some mineral exploration.

2.3.3.4 Mitigation Measures

Protection of Wildlife and Terrestrial Habitats - The rigid constraints on road width and clearing limits would effectively limit impacts resulting from habitat alteration. Prevention of debris or rock slides as discussed below under "Hazard Protection" would also help to minimize surface disturbance.

Disturbance to wildlife from noise and activity would be the most significant wildlife impact and could be alleviated to some extent by timing of activities, although the desire to complete construction in one season reduces the options. Blasting in the immediate vicinity of the Wilson estuary, if needed, would be avoided during the spring and fall waterfowl migration periods.

Final road alignments would maintain as large a buffer as possible between the road and existing eagle nests. The current road alignment would pass within 60 meters (200 feet) of four bald eagle nests and, thus, would be inside the 100-meter (330-foot) buffer zone that is required around eagle nest trees as per a Memorandum of Understanding between the U.S. Fish and Wildlife Service and the U.S. Forest Service. It would be necessary to obtain a permit from the U.S. Fish and Wildlife Service to construct the road within the buffer zone. Construction and other activities within the buffer zone would be prohibited during the nest establishment period (March 1 -

April 30) for all nests. If any of the nests are occupied, construction and other activities within the buffer zone of that nest would be prohibited during the egg laying, incubation and rearing periods (April 30 - August 31) unless a waiver is obtained.

Personnel would be strictly prohibited from feeding animals or leaving edible materials in construction zones in order to prevent attraction of animals, especially bears, as is currently required by State statute.

Protection of Water Quality and Quantity and Fish Habitats - Transport of eroded soil materials from construction zones into nearby streams and the consequent potential damage to fish habitats probably represents the most serious potential impact associated with the proposed action. The best means of mitigating such impacts is the initial prevention or minimization of construction-related erosion. The importance of the fishery issue would justify the use of the best state-of-the-art methodology for controlling water quality impacts during and after construction of the access road. The Forest Service Manual (Chapter 7720) provides some guidelines but is not specific enough to assure effective mitigation. A number of construction and design manuals have been prepared that describe detailed mitigative techniques that would be directly applicable to construction of the Blossom River access road:

- Logging Roads and Protection of Water Quality - U.S. Environmental Protection Agency.
- Planning Forest Roads to Protect Salmonid Habitat - U.S.D.A. Forest Service.
- Southeast Alaska Area Guide - U.S.D.A. Forest Service.
- Timber Harvesting and Water Quality Management - Alaska Department of Environmental Conservation.
- Transportation and Water Quality: A Manual of Recommended Practices for Transportation Corridor Development - Alaska Department of Environmental Conservation.

It is beyond the scope of this document to provide a detailed review and recommend site-specific construction and rehabilitation practices. Some general practices that would be employed are described below:

- Energy dissipators would be used on culvert pipes to protect downhill slopes from erosional forces.
- Seed and mulching material for revegetating disturbed areas would be maintained on site.
- Seed and mulch would be applied to all landslide debris areas within 48 hours of an event.
- Materials from landsliding which land upon the roadway would be end-hauled to an approved disposal area.
- Cut banks and side cast materials would be seeded and mulched as early as possible to allow germination and establishment during 1982.
- A variety of techniques such as brush barriers, check dams and settling basins would be used to capture sediment and minimize transport into waterways.
- Roadside drainage control via ditching and other techniques would be used to prevent erosion of the roadway surface and to direct surface flow away from erodable areas.
- In selected areas, roadway spoil would be end-hauled to an approved disposal site rather than cast to the side of the road.

The Alaska Department of Fish and Game has placed restrictions on construction timing for parts of the proposed road to protect fish resources. Instream work for the Tunnel Creek bridge crossing would only be permitted during the period April 1 to July 1.

The fuel storage area within the proposed marshalling yard could potentially be the source of a large fuel spill adjacent to an ecologically sensitive area. If tanks with built-in self-containment are not used, fuel tanks would be placed in a diked area lined with an impervious membrane. The diked area would be capable of containing 110 percent of the tank volume. Contingency plans would be developed to address accidental spills. Such plans would comply with requirements of the National Oil and Hazardous Substances Pollution Contingency Plan.

Grounding of rafted or stored logs would be prevented by proper location of booms.

Surface drainage on the marshalling area surface would be controlled by grading and impermeable perimeter ditches to prevent direct entry of potentially polluted drainage water into Wilson Arm. A water treatment system to remove pollutants would be employed prior to the discharge point and effluent water quality would conform with State and Federal standards.

Unless abandoned and rehabilitated, a program of continued road maintenance would be essential to assure minimization of erosion impacts, especially from such occurrences as debris slides, failure of drainage structures, etc.

Protection of Aesthetic Values - Visual impacts of project facilities would be minimized whenever possible. Site-specific visual impact measures would be identified in work plans and specifications. The following is a list of some techniques that could possibly be used.

- Any road cuts exposing rock faces could be constructed in such a way that a series of ledges or benches would be created that could provide planting pockets for small seedlings, grass or alder. Over time these exposed rock faces would tend to mimic natural rock faces.
- Rock fill slopes along shorelines could be covered with overburden and planted with shrubs, alder or conifer seedlings.
- Cut and fill slopes would be seeded when possible.
- All right-of-way clearing slash and loose rock created by rock cuts would be cleaned up where feasible.

Hazard Protection - The principal hazards that may affect the bulk sampling road along this alignment would be torrential flooding on the stream crossings, which could destroy bridges, and shallow landslides either above or below the road grade, which could affect the utility of the road and could also lead to environmental damage. These potential problems would be mitigated to the extent possible by controlling blasting and fill placement operations, and controlling drainage. Backslopes would be designed and scaled to minimize any potential rock falls. Embankments would generally be constructed using shot rock. No significant soil embankment construction is planned.

Human safety during blasting activities would be protected using normal safe construction procedures including two-way communications and clearing of personnel from areas prior to blasting. Aircraft would be warned in advance of blasting schedules and aircraft presence would be monitored.

Implementation - It has been routine practice for the Forest Service to attach "special project specifications" to special use permits for construction in the Tongass National Forest. This would provide the most effective means for assuring mitigation. Such specifications should be as specific as is practical.

Specifications will be derived from this EIS and the Southeast Alaska Area Guide. A Forest Service project engineer will be assigned to this project to review plans, monitor compliance and coordinate recommendations received from other disciplines relating to the project design or implementation.

Monitoring required of the permittee will be spot checked by the agency issuing the permit.

2.3.3.5 Environmental Impact Summary

The proposed Blossom road corridor and marine facilities would alter about 41 hectares (102 acres) of existing wildlife habitat. About 70 percent of this area is coniferous forest without exceptional wildlife use. Up to 36 hectares (90 acres) of additional forested terrain on steep slopes could be altered by landslides. About 2.7 hectares (6.2 acres) or about 2 percent of the total surface area of valuable estuarine marsh would be altered. Habitats altered by the Blossom access would be somewhat less valuable to wildlife, overall, than those altered by the Keta route; however, the significance of habitat alterations to wildlife populations resulting from either route would be minimal.

The portion of the road adjacent to Wilson Arm would pass within 60 meters (200 feet) of four bald eagle nests, at least one of which has been active in recent years. Additionally, eagles concentrate in the estuary in late summer and fall. Eagle disturbance probably is one of the more important potential wildlife conflicts caused by the roadway. The Bald Eagle Protection Act and Forest Service policy require a 100-meter (330-foot) buffer around eagle nests although exceptions can be granted by the U.S. Fish and Wildlife Service if no other options are available. Over the life of the temporary roadway, chronic disturbance of eagles would probably be unavoidable.

Movement patterns of larger mammals, primarily black bear, brown bear, and mountain goats, may be altered by the presence of the road. Bears and wolves would probably use the road as a travel route while some birds and other mammals would avoid the area because of disturbance factors. Downslope movement of mountain goats during rut and in response to snow accumulation during the winter might be impeded by the roadway and associated activity. Road cut banks could create wildlife movement barriers. Disturbance of waterfowl and other water birds, as well as black and brown bear, using the Wilson estuary may be of particular importance since the road is close to the tideflat for at least 1.6 kilometer (1 mile). The access road would provide motorized access to alpine goat and bear habitat and could result in increased harvest. Wildlife disturbance impacts would probably be somewhat less during construction of the Blossom road than would be the case for the Keta road except in relation to bald eagles.

Most of the Blossom road corridor would not involve construction directly within the Wilson or Blossom Rivers or their floodplains. However, a portion of the road about 1,100 meters (3,600 feet) long would be constructed on fill at the extreme southeast edge of the tideflat and would interfere with tidal sloughs that are used heavily by juvenile coho salmon. Some direct reduction in rearing habitat could result. The road would cross Tunnel Creek and six other streams. Of these seven creeks, only Tunnel is known to support fish in the vicinity of the proposed crossing point. Direct impact to fish habitats would be minimal on the Blossom route.

Construction of stream crossings often introduces sediment into the stream, impacting both local and downstream fish habitats. Sedimentation also can be caused by chronic erosion from the road bed or cut slopes. The Blossom route contains about 2.5 times as much steep terrain susceptible to landslides than does the Keta route; however, in some locations a substantial buffer of vegetated terrain exists between the road and streams. It is possible that 134,000 to 214,000 cubic meters (175,000 to 280,000 cubic yards) of material could be moved downhill by landslides and exposed to erosion. Of this amount, 23,000 to 32,100 cubic meters (30,000 to 42,000 cubic yards) could reach the Blossom River (see Section 4.2.1.5). Although some of these potential impacts can be mitigated by proper construction and erosion control procedures, a temporary increase in suspended sediment would be expected in the Blossom River system and lower Wilson River as a result of the road. Steep cut slopes and high precipitation would make erosion difficult to control. especially during construction.

The 1977 access road EIS (U.S. Forest Service 1977) concluded that landslides, with consequent siltation and adverse impacts on Wilson/ Blossom River fish resources, were likely. This analysis suggests that short-term impacts (e.g. reduction in spawning success for 1982 salmon run) may be significant. Chronic erosion could cause severe and prolonged siltation. Chronic erosion can normally be controlled by slope stabilization techniques and drainage control. The possibility exists. however, that sediment deposition on spawning areas occurring during construction could have permanent effects by altering the composition of stream substrates and causing decreased survival of salmon eggs. The fish resources within the zone of impact in the Blossom and lower Wilson Rivers are greater than those in the Keta River and an estimated 5 to 6 times as much sediment would enter the Blossom River than would enter the Keta River with a Keta access route. Therefore, these kinds of impacts would be potentially more serious with the Blossom route.

Some minor alteration in surface water quality in the Keta River drainage could occur as a result of underground and surface water drainage from the proposed adits and waste piles at Quartz Hill. These impacts would be identical for both access corridors and probably would not affect fish.

An oil spill resulting from storage or handling accidents at the marine facilities could potentially have serious impacts on resources of upper Wilson Arm and the estuarine area. The Wilson estuary is larger and is used by greater numbers of birds and fish than the Keta estuary. Therefore, more resources are at risk from marine accidents with a Blossom access route.

Activity as well as the facilities themselves would represent an intrusion into an area that is currently in a natural state. Visual impact as viewed from saltwater would be substantial. Aesthetic impacts would be similar with either a Blossom or Keta access; however, impacts would be more significant in Wilson Arm because of its higher existing scenic quality and the somewhat greater visibility to marine and air travellers.

Aerial and marine activities associated with the road construction and bulk sampling would intrude on the wilderness value of the National Monument and conflict to some extent with its management goals. However, ANILCA makes provision to accommodate these conflicts. Conflicts would be of greater significance with activities centered in Wilson Arm than in Boca de Quadra (as with the Keta access) because of the higher existing use and greater scenic value of adjacent areas.

2.3.3.6 Engineering and Economic Feasibility

Construction of the bulk sampling access road along the Blossom alignment is feasible. Preliminary construction cost estimates for the bulk sample roadway were initially prepared in 1976 and that estimate included an inflation factor to 1978 (Pool and Muench 1976). A more recent roadway location study (Appendix B) elevated these estimates in general terms and factored them up to mid-1981. On this basis, the expected construction cost of the Blossom River access road project is $5.2 million. Timber purchase and removal costs are included in this estimate. Acceleration of the schedule by working multiple shifts and/or multiple headings would increase these costs.

Maintenance costs have not been estimated for the access road because of its unknown life span and seasonal use. For the first several years of road use, rock and debris removal, especially at the start of each field season, would be a significant maintenance expense. This kind of maintenance would be associated with steep terrain and, thus, would be greater for the Blossom route than for the Keta route. However, the Blossom route would not be subjected to severe avalanche or flooding hazards as is the Keta route, and, therefore, it would not be likely that bridges or major road sections would have to be rebuilt during the life of the road.

The most difficult construction problem along this route will be the many areas of extremely steep to precipitous terrain that must be traversed. Full or partially benched construction requiring extensive rock excavation would be needed on about 25 percent of the route. It is probable that construction work on the steep hillsides will lead to or abet the formation of shallow landslides of soil over rock, possibly involving up to 214,000 cubic meters (280,000 cubic yards) of material. With these potential problems in mind, the proposed roadway would not be unusual in comparison with logging roads constructed in southeast Alaska in that the construction methodology would be similar. The terrain is, however, more severe than would normally be selected for logging road routing.

2.3.3.7 Likelihood of Blossom Access Being Used As Permanent Mine Development Road

ANILCA (503[h][3][c]) requires that this EIS discuss the likelihood of each alternative access route being used as a permanent mine development road. It was the intent of ANILCA that this likelihood be a consideration in the selection of the bulk sample access route. It would be desirable from the standpoints of both economics and environmental protection for the permanent mine development road to follow the same corridor as the bulk sample access road. Nevertheless, it is possible that the permanent mine development road could follow a different corridor than the bulk sample access road. This section briefly addresses the likelihood issue. See the CAD for a more detailed discussion of the relative merits of various mine development options.

Based on the analysis in the CAD, the Blossom access concept appears to be the most favorable from the standpoint of engineering feasibility, primarily due to a better possible arrangement of mine site facilities, a more favorable plant site location, a more reliable surface access, more favorable options for town development and shorter marine transportation distances to both Ketchikan and points south. Mine development with a roadway in the Blossom River drainage would probably have an economic advantage over a Keta River roadway. A detailed economic analysis has not been conducted that compares the two road alternatives from the standpoint of total development and operating costs; therefore, the extent of this economic advantage is not known. Some specific economic disadvantages of the Keta route are discussed further in Section 2.3.4.7. The Blossom access concept is favored by U.S. Borax (U.S. Borax 1981). There would, therefore, be no obstacle to the use of the Blossom River access route as a mine development road from the standpoints of engineering and mining economics.

Converting the 4.2-meter (14-foot) bulk sampling access road to a 11-meter (36-foot) permanent road (plus a 3-meter [10-foot] tailings pipeline corridor) would involve a substantial construction effort and would cause additional sediment to be transported from the construction area to the Blossom River drainage. Most of the sediment input from landsliding would, however, occur during development of the bulk sampling road. Due to the many variables involved, including the stability of the bulk sampling roadbed, it is not possible to estimate how much additional material could be produced during expansion of the roadway. It is expected to be much less than produced during the construction of the 4.2-meter bulk sample road. Some short-term impact to fish would occur as a result of sediment transport and deposition during road expansion. On the other hand, the development road would be paved, use high standard bridges, and have a long-term maintenance program. Therefore, stream impacts due to erosion from the roadway would be expected to decrease to negligible levels during mine operation. The expanded road width would cause substantial additional impact to the distributary channels of the Wilson River that skirt the east side of the estuary. Rechannelization or other mitigation could be required to reclaim salmon rearing habitat. Short and long-term impacts to fish resources resulting from the physical alteration of the bulk sampling corridor into a high standard permanent road would probably not be considered by themselves an obstacle to the permanent use of the Blossom River access.

The most important issue relating to permanent use of the Blossom River corridor concerns the ramifications the road would have on the location of other project facilities and the consequent environmental and socioeconomic impacts. Placement of a town or campsite and wharf facilities in Wilson Arm would have impacts much greater than those of the roadway. Additionally, disposal of tailings either into the marine environment or on land would have important impacts. These cumulative impacts are summarized in Section 2.3.3.8 and discussed in detail in the CAD. The CAD concluded that "neither of the two major development concepts proposed by U.S. Borax has a clear advantage over the other from the combined environmental and socioeconomic standpoints." Impacts to natural resources would be somewhat greater with the Blossom access concept while the Keta access concept would have socioeconomic disadvantages.

In summary, it would be very likely that the Blossom River access route would be selected by U.S. Borax for use as the permanent mine development road. However, the very important ramifications resulting from townsite development and other project activities, especially marine tailings disposal, would also have to be considered in light of the many trade-offs involved. Future analyses or environmental studies could provide information that would make either the Blossom or the Keta development concepts unacceptable and, thus, greatly affect likelihood of its use.

2.3.3.8 Potential Cumulative Effects

The major potential cumulative effect of the proposed access road construction and bulk sampling phase would occur if a decision is made to pursue full-scale mine development. In fact, the impacts of such a decision would far overshadow and overlap virtually all of the temporary and small-scale disturbances projected in this document. In addition, the major permanent impact of the currently proposed action, construction of a 4.2-meter (14-foot) wide road to the site via the Blossom River, would be expanded to provide for a 11-meter (36-foot) road width plus a 3-meter (10-foot) utility corridor. Other major features of full-scale mine development are briefly discussed below. See the CAD for additional discussions.

Mine Impacts - Full mine development would involve the excavation of a large open pit mine at the orebody, construction and operation of permanent processing facilities in the upper Beaver valley, and the use of much of the White Creek valley for overburden, waste rock, and lean ore disposal. Water quality of the Keta River drainage would be altered with either the Blossom or Keta access concept because of the waste rock disposal in the White Creek drainage. In addition, the upper Raspberry Creek valley would be required for a water storage reservoir. A town or camp would be constructed somewhere in the Blossom or lower Wilson valleys or in Bakewell Arm.

Effects on the National Monument - The long-term effects of a townsite in the Smeaton/Wilson area would be significant in relation to maintaining the values of the Misty Fjords National Monument. The values for which the Monument was established would be diminished within that Monument area that was designated, subject to ANILCA requirements, to accommodate development of the mine. Objects of scientific and ecological value would be more likely affected in the Blossom/Wilson drainages than would be the case with a Keta River access since the former is a more complex ecological system and the fact that more acres of construction and landslide disturbance will occur.

The primitive recreation experience sought by those visiting the area would be eliminated. This impact would also be more significant in the Blossom/ Wilson area since a larger number of users visit this area than the Keta drainage due largely to access and proximity to highly scenic portions of the Monument. Effects on the Monument outside of the mine development area would be largely the same as those on wilderness as described below.

Effects on the Wilderness - The Smeaton Bay/Wilson Arm is located adjacent to the portion of the Wilderness that has traditionally received the highest recreation use and is known to contain some of the most spectacular features that are reasonably accessible for enjoyment. This portion of the Wilderness is readily accessible by small boat on 1-day trips from Wilson Arm as opposed to the situation for Boca de Quadra where access is difficult except on an extended trip. Due to existing use and projections of rapidly increasing use, it is likely that impacts from a town of 3,000 or more people adjacent to the National Monument Wilderness could remove the values for which this Wilderness was designated. There would be increased demand in the townsite area for use of existing facilities, primarily recreation cabins. Several of the most heavily used cabins are located adjacent to the mine development area on Wilson Lake and Bakewell Arm. The Bakewell Lake area is a favorite sport fishing area due to trail access from saltwater. The fish ladder in the stream is an added attraction. One proposed townsite is adjacent to Bakewell Arm. Such a development would significantly reduce the primitive recreation values of that area. Increased use might easily require administrative regulation, which would do little to enhance quality of life for those in the townsite and would reduce recreation use quality enjoyed by traditional users. Such measures would probably not be necessary with development at the Boca de Quadra site.

In addition to the townsite, other effects from mine development and operation would impact the Wilderness. The most far reaching would be noise associated with blasting, milling, and aircraft use. Aircraft noise would be essentially the same for either the Blossom or Keta access concepts but would impact more sensitive areas with the Blossom access. Noise associated with road construction and use would impact key areas of the Wilderness because of proximity to high use areas as described above. Lights associated with the mine, townsite and wharf would have significant visual effects to a large area of the Wilderness.

Tailings Disposal - Disposal of tailings would constitute one of the most significant long-term impacts. The large volume (60,000 tons per day) of tailings produced would be piped either to on-land or marine disposal sites. On-land disposal would have the following advantages:

1. Maximum control of tailings runoff water.
2. Minimization of effects on deepwater benthos and demersal species.
3. Minimization of disadvantages associated with marine disposal.

On-land disposal would have the following disadvantages:

1. Requiring at least two very large tailings dams on Tunnel and Aronitz Creeks with access to both (roads in both the Blossom and Keta valleys).
2. Affecting a large amount of terrestrial wildlife habitat.
3. Major visual impact from heads of both Wilson Arm and Boca de Quadra and from the air.
4. Potentially adversely impacting small but significant salmon runs in the lower portions of Tunnel and Aronitz Creeks (dependent on nature of tailings runoff released to the creek).
5. Potentially adversely impacting shallow water estuarine biota using the east side of the Wilson and Keta deltas (dependent on nature of tailings runoff released to the creeks).
6. Requiring control of the quality of natural runoff from a large watershed area in addition to the large volume of tailings runoff.
7. Requiring long-term post-operational monitoring of dam safety and runoff quality.

Marine disposal would have the following advantages:

1. Elimination or minimization of disadvantages associated with land disposal.
2. Less capital construction and operation cost through project life.
3. Confinement of disposal to one basin.

4. Eliminating potential for long-term, post-operational engineering and maintenance activities.

Marine disposal would have the following disadvantages:

1. Filling a significant proportion of the total volume of the Smeaton/Wilson fjord with attendant destruction or alteration of existing benthos and likely reductions in demersal fish and shellfish use..
2. Long-term alteration of the bed material of the fjord from the existing natural sediments to a tailings substrate (not necessarily deleterious).
3. Losses of planktonic organisms entrained in the seawater dilution intake.
4. Water quality degradation in the vicinity of the discharge.
5. Need for construction of a pipeline along the fjord wall, thus extending visual impact seaward from the head of Wilson Arm.

With the data now available, the impacts of marine tailings disposal (should that option be chosen) are clearly the most difficult to predict of the potential impacts of full mine development. Oceanographic and biological studies currently underway, as well as a more complete characterization of the physical and chemical properties of the tailings expected to be gained during the bulk sampling phase, will greatly increase the predictability of marine impacts.

Socioeconomic Impacts - Development and operation of the mine would have a major impact on the Ketchikan economy, especially if workers' families were housed in Ketchikan. The number of residents that would be added to the area would represent about an 18 percent increase in the borough's current population. This would create an equivalent increase in demand for housing, transportation, and social services that would require a considerable capital outlay both initially for construction of facilities and annually for maintenance of both facilities and services.

2.3.4 Bulk Sampling with Surface Access Via the Keta River

2.3.4.1 Marine Facilities

The Keta River access route would require that marine facilities be constructed on Boca de Quadra near the mouth of the Keta River. These facilities would be essentially identical to those described for the Blossom River access alternative. A layout of the facilities on Boca de Quadra is presented in Figures 2-11, 2-12, and 2-13. Precise locations could vary somewhat pending final design.

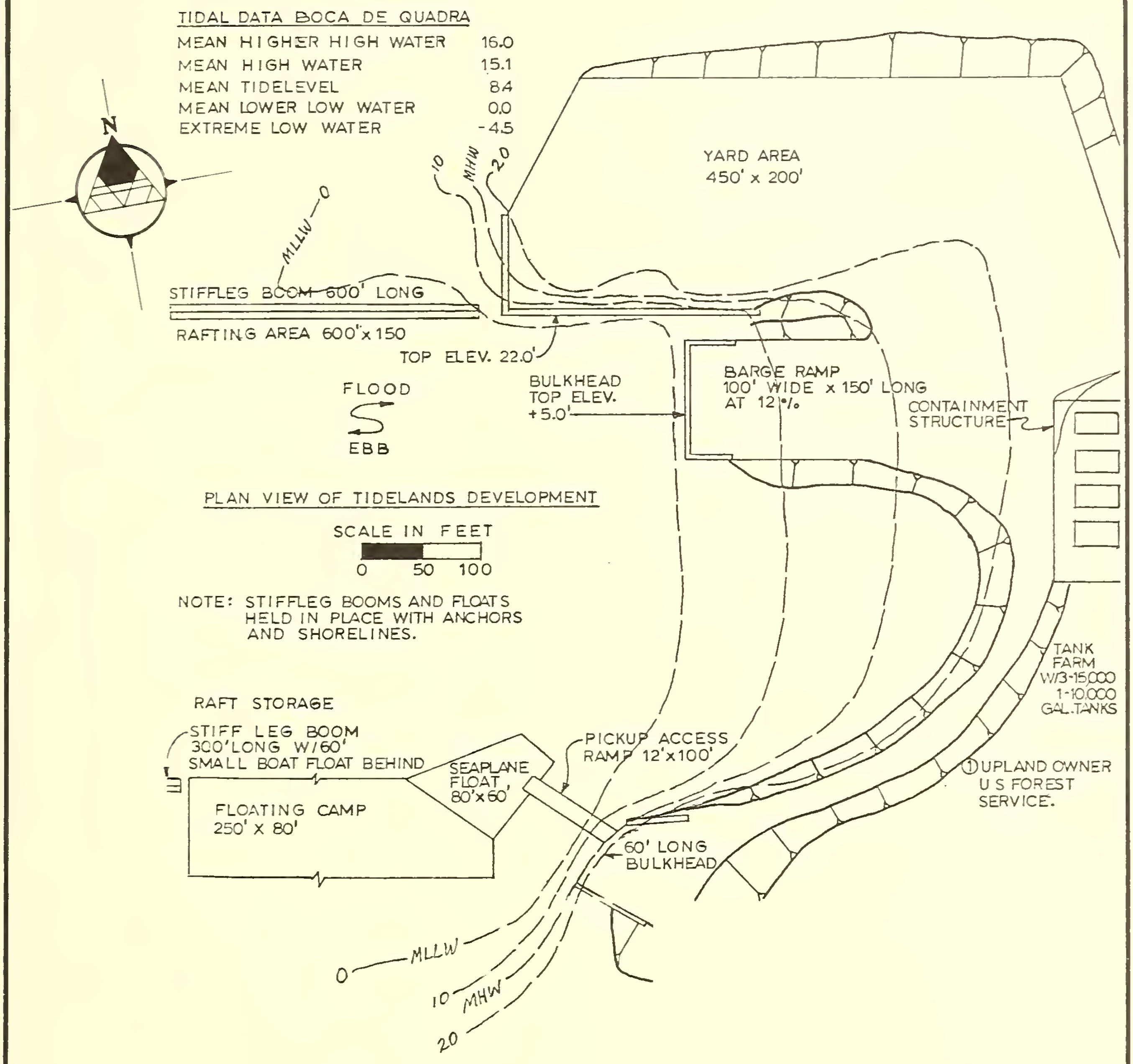
The proposed location for the marshalling area is on relatively gentle sloping terrain. Some blasting would be required, but the extent would be less than that required for the proposed Wilson Arm facility. The amount of excess shot rock available for use as road fill would be less than would result from excavation on Wilson Arm. It is possible that no extra rock would be available.

Under ideal circumstances, construction of marine facilities would be initiated in spring of 1982, concurrent with access road construction, and completed in the late summer of 1982.

2.3.4.2 Camp and Support Facilities

Camp requirements and the proposed camp facilities associated with the Keta River access alternative would be esentially identical to that described for the Blossom River access alternative. The location of the proposed floating camp in relation to other marine facilities is shown on Figure 2-11.

Waste disposal and potable water facilities would also be similar to those described for the Blossom River access alternative. Discharge of treated liquid waste would be into the water of Boca de Quadra as prescribed by the discharge permit.

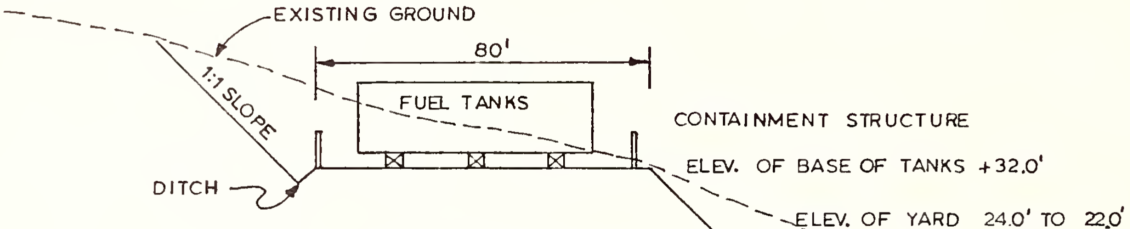


QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

MARINE FACILITIES
KETA RIVER ACCESS

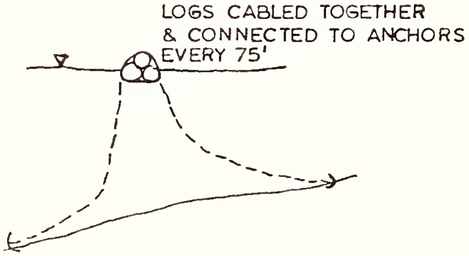
Source: Charles Pool & Assoc., Inc.

Figure 2-11



SECTION VIEW OF FUEL TANK FARM AREA

NOT TO SCALE



STIFFLEG BOOM DETAIL

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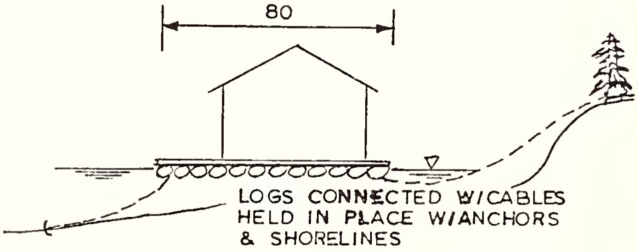
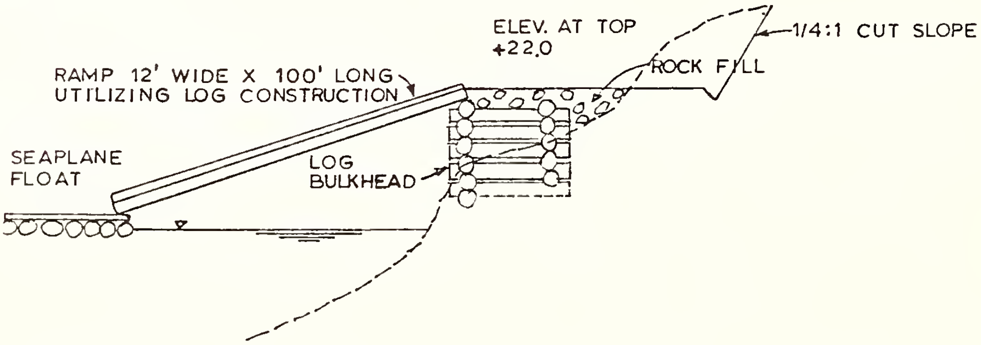


FLOATING CAMP DETAILS

NOT TO SCALE



PICK UP ACCESS RAMP

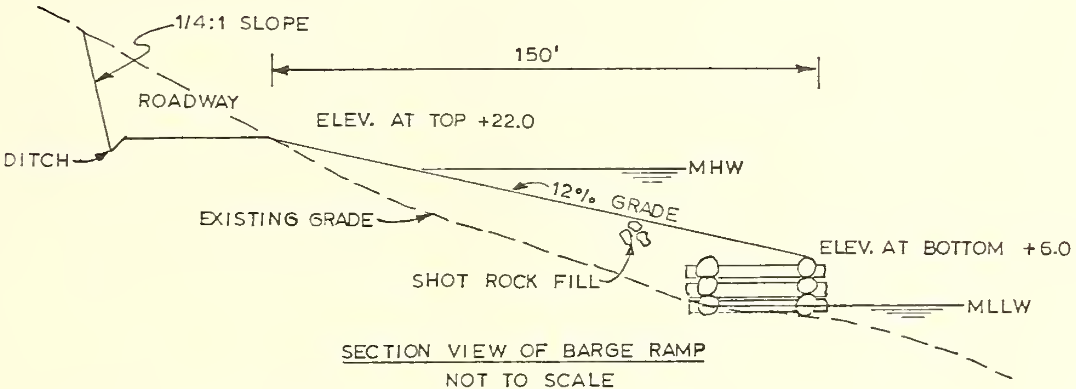
NOT TO SCALE

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

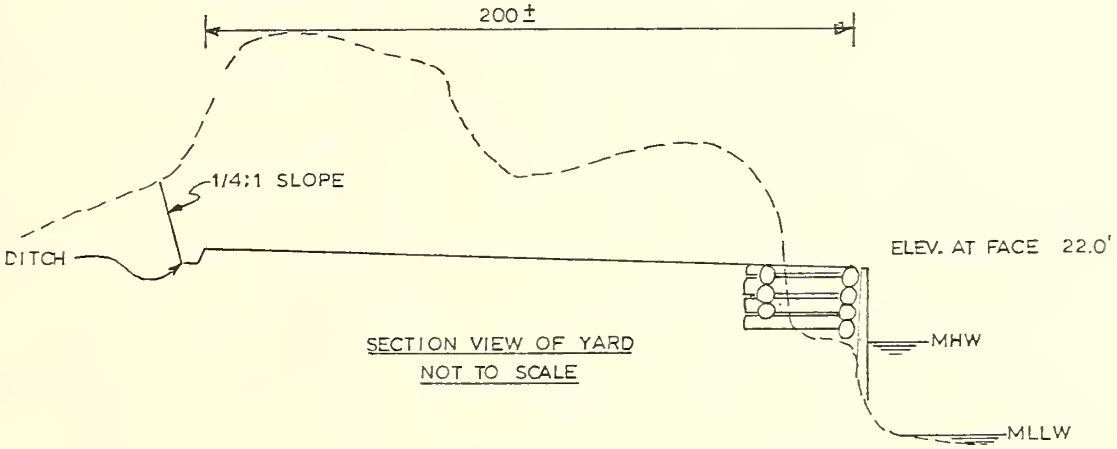
MARINE FACILITIES
SECTION VIEWS
KETA RIVER ACCESS

Source: Charles Pool & Assoc., Inc.

Figure 2-12



SECTION VIEW OF BARGE RAMP
NOT TO SCALE



SECTION VIEW OF YARD
NOT TO SCALE

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

MARINE FACILITIES
SECTION VIEWS
KETA RIVER ACCESS

Source: Charles Pool & Assoc., Inc.

Figure 2-13

2.3.4.3 Access Road

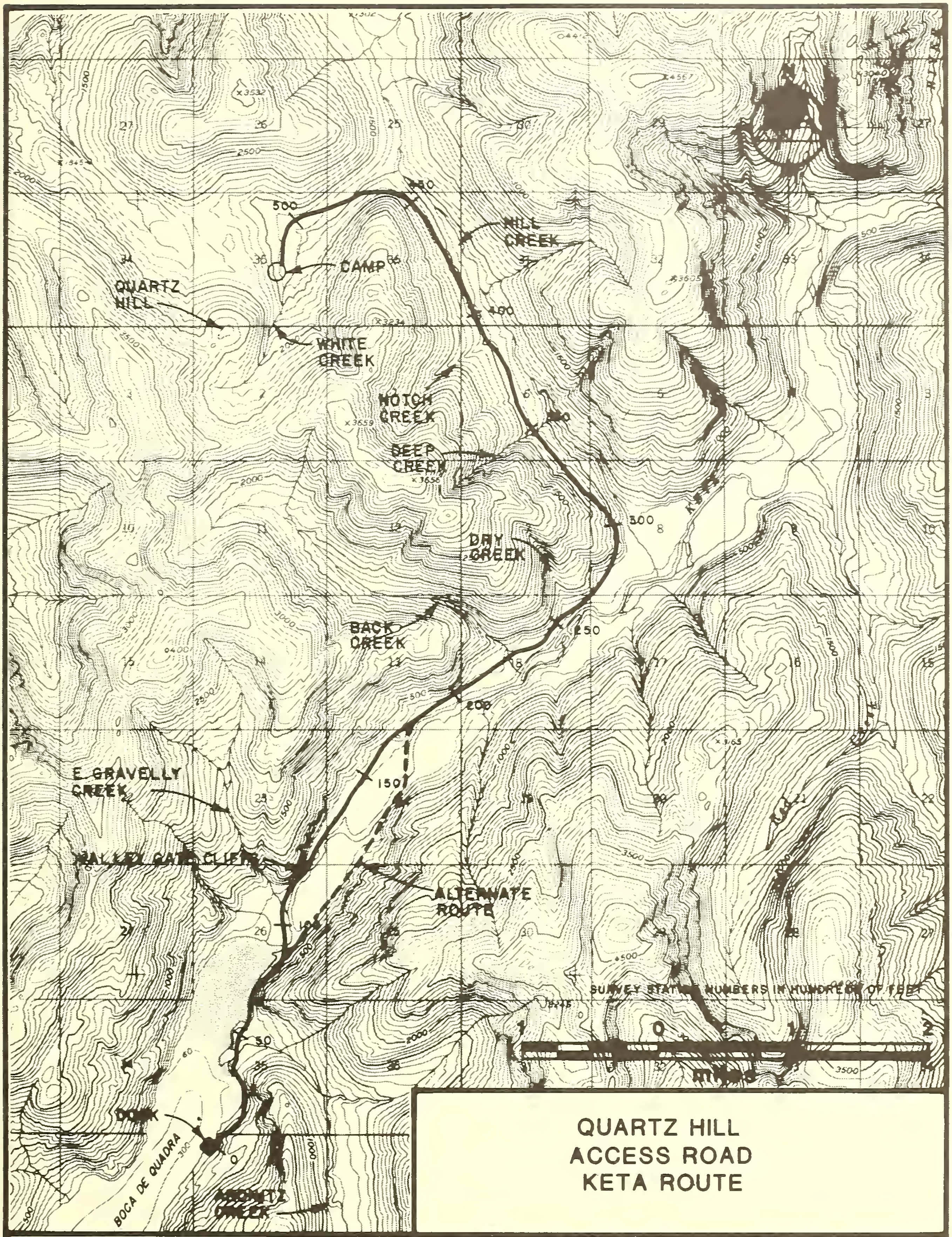
Appendix B provides a detailed description of the road corridor, geotechnical conditions and constructability.

Design and Construction - Basic design and construction techniques would be identical to those proposed for the Blossom River access except that at least two steel prefabricated bridges would be required (as opposed to temporary timber bridges), one over the Keta River and the other at Aronitz Creek.

Route Description - The Keta road alternative begins at a marine facilities site on the southeast side of Boca de Quadra near its head (Figure 2-14). It runs along the southeast side of the fjord and the Keta River tidelands for roughly 3.2 kilometers (2 miles), then crosses the Keta River to the northwest side of the valley. It then follows the Keta River floodplain for about 6.4 kilometers (4 miles) departing from it at least once to cross a short segment of upland terrain, to a point near the confluence of Hill Creek and the Keta River. At a point roughly 8 kilometers (5 miles) from the marine facilities, the road ascends into the Hill Creek valley by traversing a steep rocky ridge between the two streams. From that point, it lies along the southwest side of the Hill Creek valley to its confluence with White Creek. The road then follows the White Creek valley, crossing the stream once to the Quartz Hill camp. The total distance is slightly over 16 kilometers (10 miles). An optional routing (Figure 2-14) follows the southeast side of the Keta River floodplain for about 3.2 kilometers (2 miles) before crossing the Keta River.

The bulk sampling road would be constructed in generally the same alignment corridor as the proposed mine development road. This procedure would not only minimize environmental disruption, it also would allow the bulk sampling road to serve as the initial access route for construction of the development roadway.

The bulk sampling road route can be conveniently subdivided into five segments (Appendix B). The first of these has been called the "Wharf to



QUARTZ HILL
ACCESS ROAD
KETA ROUTE

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

Figure 2-14

Valley Gate Cliffs segment." It has a length of about 4 kilometers (2.5 miles). Construction of the roadway would require roughly 914 meters (3,000 feet) of rock excavation and two bridges. One bridge, a major structure, would cross the Keta River, the other bridge would cross Aronitz Creek.

The second terrain segment has been called the "Valley Gate Cliffs to Dry Creek Area segment." This segment has a length of roughly 5 kilometers (3-1/4 miles) and throughout most of it the roadway would lie on the floodplain of the Keta River. In one area where the river flows against the steep rock-supported valley side, roughly 90 to 120 meters (300 to 400 feet) of rock excavation would be needed to accommodate the roadway. At another point, the alignment leaves the floodplain to traverse upland terrain for roughly 300 meters (1,000 feet). The alignment crosses a tributary, Back Creek, and would require a temporary bridge about 18 meters (60 feet) long. The optional routing on the southeast side of the floodplain would avoid some of the rock cuts associated with the "Valley Gate Cliffs."

The third segment has been called "Dry Creek into Hill Creek Valley segment." It has a length of roughly 1.6 kilometer (1 mile). In that distance the road alignment ascends from the Keta River floodplain into the Hill Creek valley. In so doing, it wraps around the nose of a steep to precipitous rock ridge. Most of this segment would require full or partial rock bench construction.

The fourth roadway segment has been called the "Hill Creek segment." In this portion, the alignment lies along the southwestern side of the Hill Creek valley, a distance of roughly 4.8 kilometers (3 miles). Three temporary bridges would be required to cross an unnamed creek (estimated length 20 meters [65 feet]), Deep Creek (estimated length 21 meters [70 feet]), and Notch Creek (estimated length 18 meters [60 feet]). The potential for landslides along this segment is low to moderate. The alignment crosses six major avalanche tracks (including the Notch Creek and Deep Creek valleys). Bridges should not be expected to last more than one season at Deep Creek and one or two seasons at Notch Creek.

The last segment has been called the "White Creek to Mine segment." It has a length of roughly 1.6 kilometer (1 mile) up the White Creek valley. The terrain is gently to moderately sloping. Two temporary bridges would be needed, one with a length of about 15 meters (50 feet) where the road crosses White Creek and the other with a length of about 20 meters (70 feet) where the road crosses an unnamed tributary stream that enters White Creek from the north. Much of this segment would traverse muskeg areas where a significant fill overlay would probably be needed to form a stable grade.

Construction Schedule and Sequence - If all approvals are granted, U.S. Borax would prefer to initiate road construction at the beginning of the 1982 construction season. The Alaska Department of Fish and Game has placed restrictions on construction timing for parts of the proposed road to protect fish resources; instream work would only be permitted during the period April 1 to July 1. Because of these restrictions, as well as the requirements for two substantial bridge structures, it is anticipated that two construction seasons would be required but construction could conceivably be completed in one season. The road would be completed during either the 1982 or the 1983 field season. Work would proceed from at least three separate locations:

1. From the marshalling area working toward Quartz Hill.
2. From a location near the Hill Creek/Keta River confluence. Work would proceed in both directions and equipment would be airlifted to the site.
3. From the Quartz Hill area. Equipment would be airlifted to the site.

Road Use - Road use would be identical to that described for the Blossom River access road.

2.3.4.4 Mitigation Measures

Mitigation measures for the Keta River access route would be essentially the same as described for the Blossom route in Section 2.3.2.6 except for some special considerations.

Timing restrictions in relation to bald eagle nests would probably not be required for the Keta. The proposed Keta road route appears to pass outside of the required buffer distance in relation to the two nest trees on the Aronitz Creek delta.

Construction of the Keta River access road would involve some direct alteration of the Keta River as well as substantial work immediately adjacent to a long section of the lower Keta River. The Keta River bridge would entail instream construction work. Additionally, blasting would be required adjacent to the river in the "Valley Gate Cliffs" area for the primary route option. The timing of these activities would be critical to protect fish resources. The Alaska Department of Fish and Game has limited work in any active Keta River stream courses, including side channels and sloughs, to the period April 1 to July 1 in order to protect spawning adult salmon, incubating eggs and emerging fry (ADF&G 1978). Sensitive time periods would also be considered when planning blasting programs and other intensive activities near the river.

The road would encroach on the river in two main channel areas and two backwater locations, necessitating rechannellization or restriction of the river flow. Rechannelled areas would be carefully designed to minimize hydraulic changes in the river that could affect spawning habitat quality. Road embankments would be adequately armored to assure stability under flood flow conditions.

Two kinds of hazards are likely to affect the bulk sampling road along this alignment. These include destruction of bridges by either flooding or avalanches. Human risk would be low since the road would only be used during the summer or early fall. There is probably no practical way to avoid damage or destruction of the roadway and the bridges in flood and avalanche areas, given the temporary service life of this roadway. However, the use of removable bridge structures could minimize damage by allowing bridges to be removed and replaced seasonally. The potential slide-related problems would be mitigated to a degree by controlling blasting, fill placement operations, and drainage. Backslopes would be designed and scaled to minimize any potential rockfalls. Embankments would generally be constructed using shot rock.

Implementation of mitigation measures would be as described in Section 2.3.3.6.

2.3.4.5 Environmental Impact Summary

The proposed Keta road corridor and marine facilities would alter about 45 hectares (110 acres) of existing wildlife habitat, nearly half of which is on the Keta River floodplain or estuarine marsh and, thus, would be considered to have relatively high value. The northern portion traverses the steep Hill Creek valley, an area of low wildlife value. Habitats altered by the Keta access would be somewhat more valuable, overall to wildlife, than those altered by the Blossom route; however, the significance of habitat alterations to wildlife populations resulting from either route would be minimal.

The segment of road that skirts the head of Boca de Quadra would pass in close proximity to two eagle nests, neither of which is known to be active at the present time but could become active in the future. Eagles concentrate in the estuary area in late summer and fall and disturbance to eagles may be an important impact of the road especially since it crosses the lower Keta floodplain in the area of eagle use. Eagle use of Boca de Quadra is somewhat less than in Wilson Arm. Impacts to eagles would be significantly less for the Keta route as compared to the Blossom route because only two nests are involved and the road passes outside of the required 100-meter (330-foot) buffer zone. Other impacts on wildlife would be similar to those of the Blossom route. Disturbance to black bears and waterfowl would likely be greater for the Keta route because of the location of the road adjacent to estuarine and riparian habitat types. The road crosses from one side of the floodplain to the other and, thus, could interfere with animal movements down the valley toward the estuarine marsh.

The portion of this route that parallels the Keta delta and impinges on the estuarine marsh would have impacts similar to those described for the Blossom road except that only 425 meters (1,400 feet) of roadway would be on the tideflat and a smaller portion of salmon rearing habitat would be altered. About 1 percent of the total marsh area would be altered.

The Keta road corridor would cross the Keta River via a bridge, then follow the Keta floodplain for a distance of about 6.4 kilometers (4 miles) and Hill Creek for about 8 kilometers (5 miles). The roadway would encroach on active river channels, backwater areas, ponds and wetlands in some places. Therefore, direct disturbance to fish habitat would occur. Good planning and construction techniques would minimize direct impacts but some reduction in the productivity of fish spawning and rearing habitats would be a likely consequence.

Indirect impacts resulting from construction or erosion generated siltation would be similar to those described for the Blossom Route except that:

1. The Keta route has much less steep, landslide-prone terrain (about 10 percent of its length) than does the Blossom route (about 25 percent); therefore, less soil would be available for transport.

2. The close proximity of the Keta route to major streams suggests that sediment transport problems would be more difficult to control and would not have the mitigating benefit of as much intervening vegetated terrain when compared to the Blossom route.

These two opposing factors would tend to partly cancel each other out. This analysis suggests that short-term impacts would be less for the Keta route compared to the Blossom route, although they could potentially occur over two construction seasons rather than one. It is possible that 19,000 cubic meters (25,000 cubic yards) of material could be moved by landslides and exposed to erosion along the Keta route. Of this amount, 4,400 to 5,000 cubic meters (5,700 to 6,800 cubic yards) could reach the Keta River (see Section 4.3.1.2). Soil material reaching the Keta River would be approximately 20 percent of that which would reach the Blossom River as a result of Blossom access road construction. The fish resources within the zone of impact in the Keta River are less than those in the Blossom River. Therefore, impacts, if they occurred, would be potentially less serious with the Keta route.

Some minor alteration in surface water quality could occur as a result of underground and surface drainage from proposed adits and waste piles at Quartz Hill. These impacts would be identical for both access corridors and probably would not affect fish.

A major oil spill resulting from storage or handling accidents at the marine facilities could have serious impacts on resources of upper Boca de Quadra and the estuarine area. The Keta estuary is smaller and is used by fewer birds and fish than the Wilson estuary. Therefore, less resources are at risk from marine accidents with a Keta access route.

Visual impacts as viewed from saltwater would be substantial. Aesthetic impacts would be similar with either a Blossom or Keta access; however, impacts would be less significant in Boca de Quadra because of its lower existing scenic quality and the somewhat poorer visibility to marine and air travellers.

Aerial and marine activities associated with the road construction and bulk sampling would intrude on the wilderness value of the National Monument and conflict to some extent with its management goals. However, ANILCA makes provision to accommodate these conflicts. Conflicts would be of less significance with activities centered in Boca de Quadra than in Wilson Arm (as with the Blossom access) because of the low existing use and moderate scenic value of adjacent areas.

2.3.4.6 Engineering and Economic Feasibility

Construction of the bulk sample road along the Keta alignment is feasible. Preliminary construction cost estimates for the bulk sample roadway were initially prepared in 1976 and that estimate included an inflation factor to 1978 (Pool and Muench 1976). A more recent roadway location study (Appendix B) evaluated these estimates in general terms and factored them up to mid-1981. On this basis, the expected construction cost of the Keta bulk sampling road project is $4.3 million. Timber purchase and removal costs are included in this estimate. Acceleration of the schedule by working multiple shifts and/or multiple headings would increase these costs.

Maintenance costs have not been estimated for the Keta River access road because of its unknown life span and seasonal use. As discussed below, avalanche paths crossing the road route would be likely to create significant maintenance expenses if the road were to be used for several years. Some bridges would have to be re-built each year or, alternatively, temporary bridges would have to be removed and replaced seasonally. Maintenance costs relating to rock and debris slides would be less for the Keta road than for the Blossom. Assuming road use for several years, overall maintenance costs would probably be higher for the Keta route than for the Blossom.

The area where the route "turns the corner" from the Keta River valley into the Hill Creek valley involves precipitous rocky terrain with many cliff segments. Also, there are some areas, notably in the lower portion of Hill Creek valley, where the roadway will traverse steep cross slopes with a soil cover. Full or partially benched construction requiring extensive rock excavation would be needed on about 10 percent of the route. In those areas, it is likely that road construction may lead to or abet the formation of shallow landslides of soil over rock possibly involving up to 19,000 cubic meters (25,000 cubic yards) of material. The Keta River bridge site dictated by the optional routing is judged to be less desirable than the primary route site because of less stable channel conditions.

The Hill Creek segment crosses a number of active avalanche tracks, some of them quite major. Since the road is intended for short-term summer season use, the avalanche issue should not be significant to the intended purpose of the road or cause a safety hazard. Nevertheless, it is unlikely that several of the bridges in this area would last for more than a few years. A temporary Deep Creek bridge, for example, is likely to be destroyed virtually every winter and would have to be replaced seasonally to allow continued road use.

With these potential problems in mind, the proposed roadway would not be unusual in comparison with logging roads constructed in southeast Alaska in that the construction methodology would be similar. The terrain is, however, somewhat more severe than would normally be selected for logging road routing. The Keta access road would be somewhat easier to construct and less expensive than the Blossom access road but would probably require a longer construction period.

2.3.4.7 Likelihood of Keta Access Being Used As Permanent Mine Development Road

ANILCA (503[h][3][c]) requires that this EIS discuss the likelihood of each alternative access route being used as a permanent mine development road. It was the intent of ANILCA that this likelihood be a consideration in the selection of the bulk sample access route. It would be desirable from the standpoints of both economics and environmental protection for the permanent mine development road to follow the same corridor as the bulk sample access rod. Nevertheless, it is possible that the permanent mine development road could follow a different corridor than the bulk sample access road. This section briefly addresses the likelihood issue. See the CAD for a more detailed discussion of the relative merits of various mine development options.

As described in the CAD, the Keta access concept for total mine development is considered somewhat less desirable than the Blossom concept from the standpoint of engineering feasibility. The arrangement of mine site facilities as currently proposed would be less convenient, the access road would be faced with avalanche hazards, the options for town or campsite development are less desirable, and transportation costs would be higher due to greater distance. U.S. Borax (1981) has indicated that the Keta concept is a second choice. Mine development with a roadway in the Keta River drainage would probably have an economic disadvantage when compared to a Blossom River route. A detailed economic analysis has not been conducted that compares the two road alternatives from the standpoint of total development and operating costs; therefore, the extent of this economic disadvantage is not known. Some specific items that would contribute to the cost disadvantage are as follows:

- Marine transportation from Ketchikan to the head of Boca de Quadra would be about 30 percent (22 kilometers [14 miles]) farther than to the head of Wilson Arm, requiring proportionately higher transportation costs.

- Mine development road maintenance costs could be up to 33 percent higher (about $100,000 per year) for the Keta route primarily because of avalanche control requirements (Appendix B). These cost estimates, however, did not consider that an avalanche control program would be required for the mine area regardless of road route.

- Substantial energy could be required to pump tailings from the preferred processing plant site over a divide to the Keta River drainage. An alternate plant site in the Keta River watershed is available but subject to avalanche hazards.

Approximately 1,000 meters (3,300 feet) of the road length would be subject to avalanche hazards (see Appendix C). Some locations could experience several avalanche discharges per season. However, through an active avalanche control program, the hazard could be reduced to a level comparable to that accepted for some public highways (Appendix C; Wilson 1981). Some controlled road closures would be required but the road would be available for at least 98 percent of the snow season (Wilson 1981).

In spite of the above disadvantages, the analysis presented in the CAD suggested that there are no factors that would preclude the use of the Keta

River access concept from the standpoints of engineering feasibility or mining economics. Therefore, there would appear to be no engineering obstacle to the use of the Keta River access route as a mine development road, although there would be an economic disadvantage.

Converting the 4.2-meter (14-foot) bulk sampling road to an 11-meter (36-foot) permanent road (plus a 3-meter [10-foot] tailings pipeline corridor) would involve a substantial construction effort and would cause additional sediment to be transported from the construction area to the Keta River drainage. Most of the sediment input from landsliding probably would occur during development of the bulk sampling road. Due to the many variables involved, including the stability of the bulk sampling roadbed, it is not possible to estimate how much additional material could be produced during expansion of the roadway. It should be less than that caused by construction of the 4.2-meter bulk sampling road. Some short-term impact to fish would probably occur as a result of sediment deposition. Tripling the road width could cause some special additional problems in those areas where the road directly conflicts with active channels or sloughs of the Keta River. Substantial rechannelization would be required. Filling of slow water habitats would be accompanied by a probable loss of fish productivity. Additional expansion onto the estuarine marsh and intertidal channels would encounter problems similar to, but less severe, than those described for the Blossom access. On the other hand, the development road would be paved, use high standard bridges, and have a long-term maintenance program. Therefore, stream impacts due to erosion from the roadway would be expected to decrease to negligible levels during mine operation. Short and long-term impacts to fish resources resulting from the physical alteration of the bulk sampling road into the mine development road would probably not be considered by itself an obstacle to the permanent use of the Keta River access although such impacts would probably be somewhat greater for the Keta route than the Blossom route.

The most important issue relating to permanent use of the Keta River corridor concerns the ramifications the road would have on the location of other project facilities and the consequent environmental and socioeconomic impacts. Placement of a town or campsite and wharf facilities in

Boca de Quadra would have impacts much greater than those of the roadway. Additionally, disposal of tailings either into the marine environment or on land would have important effects. These cumulative impacts are summarized in Section 2.3.4.8 and discussed in detail in the CAD. The CAD concluded that "neither of the two major development concepts proposed by U.S. Borax has a clear advantage over the other from the combined environmental and socioeconomic standpoints." Impacts to natural resources would be somewhat less with the Keta access route while socioeconomic impacts would be somewhat greater.

In summary, the Keta access route would have somewhat less likelihood of being selected by U.S. Borax for the permanent mine development road than would the Blossom access because of engineering, economic, and safety disadvantages. However, the very important ramifications resulting from townsite development and other project activities, especially marine tailings disposal, would also have to be considered in light of the many trade-offs involved. Future analyses or environmental studies could provide information that would make either route unacceptable and, thus, greatly affect likelihood. Since the Keta route is considered feasible from the standpoint of mining engineering, it should still be considered a viable alternative.

2.3.4.8 Potential Cumulative Effects

As with the Blossom access alternative, the major potential cumulative effect of the Keta access road construction and bulk sampling phase would occur if a decision is made to pursue full-scale mine development. The impacts of mine development would far overshadow and overlap virtually all of the temporary and small-scale disturbances projected in this document.

Mine Impacts - Impacts at Quartz Hill from mining and processing would be similar in magnitude to those described for mine development under the Blossom access option (Section 2.3.3.8). The water reservoir would be in the upper Hill Creek valley instead of in Raspberry Creek. The 4.2-meter (14-foot) access road along the Keta River and Hill Creek would be expanded and modified to the 11-meter (36-foot) mine road paralleled by a 3-meter (10-foot) utility corridor. This route would require significant initial and annual costs for control of avalanches in the Hill Creek valley. Disturbance of White, Upper Beaver, and Upper Hill Creek valleys would be of the same order of magnitude but in a somewhat different configuration than under the Blossom access alternatives. The major impact to White Creek from waste rock disposal would occur with either access concept.

Effects on the Monument - A town or camp would be constructed either at the mouth of the Keta River or Aronitz Creek. A townsite in the Boca de Quadra area would have less severe long-term impacts on National Monument values as would a town in the Smeaton/Wilson area.

The values for which the Monument was established would be threatened within the Monument area that was designated, subject to ANILCA requirements, to accommodate development of the mine. Objects of ecological and scientific value would be less likely to be affected when compared to the Blossom access since the Keta River area is a less complex ecological system and is subject to less total surface disturbance from construction and landslides. The primitive recreation experience sought by those visiting the area would be eliminated. A lower number of users visit this area than the Smeaton/Wilson area due to access and distance from the more spectacular portions of the Wilderness. Effects on the Monument outside the mine development area would be largely the same as those on wilderness as described below.

Effects on the Wilderness - The Boca de Quadra area is located such that many of the impacts to wilderness values would be localized and effects on the areas of the Wilderness determined to be most spectacular and accessible to users would be less significant than if development were to occur in the Smeaton/Wilson area. Boca de Quadra provides a large area and a variety of resources that would be available to humans associated with mine development and should be able to absorb such use without threatening the values for which the Wilderness exists and without the need for administrative regulation. The Boca de Quadra area currently offers a high solitude value which would be largely diminished.

In addition to the townsite there are other effects from mine development and operation that would impact the Wilderness. The most far reaching would be noise associated with blasting, milling, and aircraft use. Noise associated with road construction and use would impact key areas of the wilderness less from Boca de Quadra than from Wilson Arm. Lights associated with the mine, townsite, and wharf would have significant visual impacts to a large area of the Wilderness. These impacts would also be less significant in Boca de Quadra because of lower use.

Tailings Disposal - The advantages and disadvantages of on-land tailings disposal under this option would be identical to those for the Blossom access option since on-land disposal areas in each drainage would be required under either option.

Marine disposal would have advantages similar to those for the Wilson/ Smeaton disposal under the Blossom access development option:

1. Elimination or minimization of disadvantages associated with land disposal.
2. Less capital construction and operation cost through project life.
3. Confinement of disposal to one basin.
4. Eliminating potential for long-term, post-operational engineering and maintenance activities.

Marine disposal would have the following disadvantages:

1. Filling a significant proportion of the total volume of the inner and central or main basin of Boca de Quadra with attendant destruction of existing benthos and likely reductions in demersal fish and shellfish use. These effects could be confined to the central basin by discharging only to it, rather than to both, as proposed.
2. Long-term alteration of the bed material of the receiving basin(s) of the fjord from the existing natural sediments to a tailings substrate (not necessarily deleterious).
3. Losses of planktonic organisms entrained in the seawater dilution intake.
4. Water quality degradation in the vicinity of the discharge.
5. The need for construction of a pipeline along the shoreline of Boca de Quadra, thus extending visual impacts seaward from the head of the fjord.

With the data now available, the impacts of marine tailings disposal (should that option be chosen) are clearly the most difficult to predict of the potential impacts of full mine development. Oceanographic and biological studies currently underway, as well as a more complete characterization of the physical and chemical properties of the tailings expected to be gained during the bulk sampling phase, will greatly increase the predictability of marine impacts.

Socioeconomic Impacts - From a socioeconomic standpoint, construction of the Keta access road and accomplishment of bulk sampling would have a minor positive impact on the Ketchikan economy identical to those with the Blossom access alternative. Development and operation of the mine would have a similar major impact on the Ketchikan economy. Mine development via the Keta River access would incur somewhat greater surface (water) transportation costs (c.f. a wharf in Wilson Arm) because of the greater distance to the head of Boca de Quadra from both the north and the south. The route from Ketchikan would also be longer.

2.3.5 Plans for Evaluation of Water Quality, Water Quantity, Fishery Habitat and Other Fishery Values of the Affected Area

2.3.5.1 Introduction

ANILCA (Section 503 [h][3][D]) states that this EIS must include "plans to evaluate the water quality and water quantity, fishery habitat, and other fishery values of the affected area . . ." This requirement is interpreted as meaning that a program should be established to monitor impacts and the effectiveness of mitigation measures. This should include contingency plans for monitoring the effects of accidental or unexpected occurrences. U.S. Borax would be required to develop and implement the monitoring program. The program would be approved in advance by the Forest Service and cooperating agencies.

The primary fish resources relative to the Blossom access occur in the Blossom and lower Wilson River; therefore, monitoring emphasis should concentrate on these waters. Similarly, for the Keta access emphasis should be on the Keta River.

2.3.5.2 Water Quality and Quantity

The following monitoring program is recommended for measurement of the effects of road construction on water quality and quantity. This program is designed to identify the types and magnitude of both short and long-term impacts.

Long-term monitoring, initiated by VTN and the U.S. Geological Survey, should continue at the existing schedule and at the established sampling sites along the selected route (Blossom or Keta). The minimum characteristics that should be measured are total suspended solids, total dissolved solids, specific conductance, pH, temperature, total phosphorus, total nitrate-nitrogen, alkalinity, hardness, iron, copper, zinc, lead, arsenic, calcium, magnesium, sulfate, and molybdenum.

A short-term monitoring program will also be initated to monitor construction activities. This monitoring program will be designed using a modified paired-station technique, which involves the establishment of two sample stations above the zone of influence and a sample station below each construction point. It will be important to locate downstream stations to insure adequate mixing, but to avoid unrelated sedimentation or other effects from instream areas. Additionally, the shortest possible time interval should occur between sampling the two stations. This may be particularly important when measuring temperature. Field measurements and laboratory sample collections should be made at least at three points across the cross-section and at depth to insure the measured values are representative of the entire stream. The parameters to be measured include but are not limited to pH, temperature, total suspended solids, turbidity, specific conductance and flow. Sampling for this analysis will be conducted on a weekly basis beginning two weeks prior to the initiation of the construction period and continue until the water quality characteristics at the downstream station return to essentially pre-construction levels.

It was stated above that the paired-station approach, with some modification, was recommended. Flexibility in the monitoring program will be required to respond to events such as landslides that would cause sudden changes in water quality. In these cases, it is recommended that two additional stations be established immediately after the slide on the stream receiving flow from the impacted tributary. These stations would be located above and below the mouth of the impacted stream and would continue to be sampled until the characteristics at the downstream station returned to ambient conditions.

A water monitoring program will continue at the mine adit sites. This program will be expanded to include the new adits to be developed. The present program analyzes daily samples for pH, total suspended solids, temperature, specific conductance, and flow. In addition, monthly samples are analyzed for total dissolved solids, sulfate, oil and grease, copper, lead, iron, molybdenum, zinc, arsenic, and manganese.

2.3.5.3 Sediment Transport Analysis

The sediment transport model to be completed for the final EIS will provide a logical basis for a future monitoring program. Development of the model has identified specific hydrological data needs that would be desirable to make the model more responsive. A program to collect this additional data should be conducted and the model refined for either the Blossom or Keta drainage systems.

Using input from the water quality monitoring (natural and induced suspended solids concentrations), the computer model could be used to predict impacts on the composition of stream substrate at any stage of construction. This information would provide a rapid check on the effectiveness of or need for mitigation measures.

2.3.5.4 Analysis of Deposition and Stream Substrate Composition

Prior to the construction period, gravel core samples should be collected from several stations within salmon spawning habitat in the Blossom/

Wilson or Keta Rivers. One station should be upstream from the zone of impact, one station should be near the river mouth, and at least one other at an intermediate point within the impact zone. It should be noted that some frozen core samples have already been collected from the lower Keta River (Edgington 1979). If the Keta route should be chosen for development, it would be desirable to use comparable methodology and station location to take advantage of this existing baseline information.

Core samples should be repeated during construction, after construction, and for a period thereafter. The composition of stream substrate particle sizes would provide an indication of whether permanent impacts on substrate composition had occurred and provide a basis for predicting potential impacts on the survival of salmon eggs and embryos.

In addition to the core sampling, it would be desirable to measure sediment deposition directly during the construction period using trays placed in the stream at selected locations. This relatively simple method would provide some indication of temporary impacts to fish habitats and, when compared to the core sampling, provide some idea what quantity of deposited sediments becomes permanently lodged in the gravels or how much is subsequently cleansed by high stream flow conditions.

Both the core sampling and sediment tray method would provide a check on the accuracy of the sediment transport model and provide a basis for fine-tuning the model.

2.3.5.5 Evaluating Impacts on Fish and Fish Food Organisms

The existing literature (Cederholm et al. 1981; Shirazi and Seim 1979) suggests that the most significant (and subtle) effect of sediment deposition in anadromous fish streams is reduction in the survival rate of salmon eggs, embryos and alevins (pre-emergent fry). Additionally, sediment deposition can alter the capacity of rearing habitats to support fish or reduce fish food availability. Therefore, a monitoring program should attempt to determine the actual effects of project-related siltation on the intragravel survival of salmon eggs in the impacted stream and on rearing area capacity.

A variety of methods such as small suction dredges have been used to sample naturally spawned salmon eggs in stream gravels. These methods should be reviewed and the most appropriate technique selected. The survival of eggs should be examined at several stations, both above and below the zone of impact during the 1982 construction season and for at least two seasons thereafter. Because of the variability in natural egg survival, the above method has some drawbacks. Another method, which is easier to control experimentally, consists of artificially placing eggs from a known stock into small incubation boxes or envelopes and burying them in stream gravels both above and below the impact zone (Cedarholm et al. 1981). The survival of these eggs would probably provide a better check on the impact of sediment deposition.

Besides altering egg survival, sediment deposition can affect fish populations by covering coarse substrate materials and reducing the quantity and diversity of small aquatic organisms (invertebrates) that provide food for fish, especially young coho and chinook salmon. The quality and quantity of available rearing habitat would also be affected by sediment deposition. Two separate sampling programs (VTN 1979, 1980b and Elliott 1980) have provided baseline information on invertebrate abundance in the Keta and Blossom Rivers that could be compared with post-construction samples to provide an indication of whether invertebrate populations had been affected. The VTN data is more complete and should probably be considered more heavily. Post-construction sampling should employ the same methodology and duplicate sampling stations as much as possible to produce comparative data.

3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

The environment of the region encompassing the Misty Fjords National Monument and the specific area of the Quartz Hill project is at present, largely in its natural pristine state. Steep forested mountainsides and shear rock cliffs rise abruptly from the depths of glacially-formed fjords. Several species of birds and mammals are locally abundant. Clear water river systems support substantial salmon runs and marine waters nurture salmon as well as other fish and shellfish resources. Human activities in the region have to date been largely limited to mineral prospecting, trapping, hunting, fishing, and sightseeing. The particular aesthetic qualities of the region have been recognized by its designation as a National Monument in the ANILCA.

Only limited quantitative information is available from scientific and resource agency assessments of the environment in the broader region of the Misty Fjords National Monument. However, a substantial body of information on the atmospheric, terrestrial, freshwater, and marine environments of the Quartz Hill area has been generated by U.S. Borax in the past several years (e.g. VTN 1978, 1979, 1980a-e; Nebert and Burrell 1981; Wilson 1980). State and Federal agencies have also performed numerous studies.

This chapter provides brief descriptions of aspects of the natural and human environments that may be affected by the proposed action. As provided by Federal (CEQ-NEPA) regulations, these descriptions emphasize those elements of the environment that are most likely to be impacted and avoid discussions unrelated to likely project impacts.

3.2 CLIMATE/METEOROLOGY/AIR QUALITY

The Quartz Hill project is located in the maritime climatic zone of southeast Alaska. This zone is typified by cool summers, mild winters and heavy precipitation. The dominant climatic factor in the region is the Pacific Ocean, which moderates temperatures and keeps moisture levels high.

Topography and elevation also have profound effects on both temperature and precipitation.

The variation between monthly average maxima and minima is low, ranging between 4° and 7°C (8° and 13°F). Monthly normal (mean) temperatures range from 0°C (33°F) in January to 14°C (58°F) in August (VTN 1980a). In the on-site meteorology program in 1980, the lowest monthly mean temperature (-11°C [12.6°F] in January) and the lowest single reading (-26°C [-14°F]) were recorded at a station west of the proposed mine site at an elevation of 1200 meters (3,900 feet). The highest monthly mean was 12°C (53.5°F) in July on Kite Island in Boca de Quadra and the highest reading was 32°C (90°F) in August at Bakewell Lake (VTN 1980a).

Normal annual precipitation in the region is 250 centimeters (100 inches) or more with October and November usually the wettest months. During 1980, the station at Quartz Hill camp (elevation 425 meters [1,400 feet]) recorded 329.9 centimeters (129.9 inches) of precipitation, while Ketchikan received 374.6 centimeters (147.5 inches) in the same period. October was the wettest (72.6 centimeters [28.6 inches]) month at the camp (VTN 1980a). At sea level in the Quartz Hill area, much of the precipitation is in the form of rain, while snow accumulations greater than 0.3 meter (1 foot) are relatively infrequent and of limited persistence, at least in recent years. At higher elevations, however, massive accumulations of snow are common. Extrapolations from the limited precipitation data at the Quartz Hill mine site suggest an average total yearly snowfall of about 22 meters (73 feet) with an average maximum of 5.1 meters (16.7 feet) on the ground (Wilson 1980). Maximum snow on the ground during a heavy snow year could exceed 6 meters (20 feet). These accumulations, coupled with the steepness of the terrain, high winds, and the lack of trees at higher elevations, create extreme avalanche conditions in many areas, including the immediate project vicinity.

Winds are frequently southeasterly from October through March as storm systems sweep in from the Gulf of Alaska. Measured wind speeds and directions vary greatly with individual instrument locations with respect to topographic features (VTN 1980a). At the ridge station near the mine site, synoptic weather patterns moving predominantly from the south or west, depending on the season, were recorded. A strong easterly component of polar air movement was present during the winter and early spring.

Detailed air quality monitoring has not been conducted at the Quartz Hill site. However, overall air quality is excellent as there are no major pollutant sources closer than Ketchikan some 72 kilometers (45 miles) to the west and Kitsault, B.C. some 56 kilometers (35 miles) to the east. The only current sources on the site are the diesel generators at the camp and exhausts from drill rigs and compressors used for the exploration program during the summer.

The Misty Fjords National Monument is designated a Class II PSD (Prevention of Significant Deterioration) area. The area is currently designated as an attainment area for all criteria pollutants (an area which currently meets ambient air quality standards for all pollutants) (Bray 1981) although no measurements have been made.

3.3 TERRESTRIAL ENVIRONMENT

3.3.1 Geology/Soil Conditions

The project area, including both of the access corridors, is basically formed by granitic rocks of Mesozoic age. These rocks are a part of the Coast Range batholith, a major intrusive rock body that forms the mountainous terrain along the Alaska-British Columbia border. These rocks are usually hard, dense, and massive, although they do include occasional zones with a gneissic or schistose texture.

The rocks generally stand on steep to very steep slopes of substantial height primarily because of their high strength and general massive occurrence. Another important factor is the nature of jointing (fracturing) of the rock. Such partings are usually widely spaced and tend to be thin, planar features without extensive crushed zones or gouge formation. In addition, glacial erosion in the region has removed the bulk of surface material that had been significantly weakened by chemical and mechanical weathering. All these factors combine to produce a very strong rock mass that is not commonly subject to large-scale slope failures.

Regional structural trends are expressed by two prominent joint and fault systems. One of these sets has a northwest-southeast trend, the other trends essentially north-south. Some of these features are very major, consisting of either faults or postulated faults with lengths in excess of 160 kilometers (100 miles). It is believed that most of these structural features were created during the major period of folding, faulting, intrusion, and metamorphism at the end of the Mesozoic era (roughly 65 million years ago).

The general topography has been extensively shaped or modified by erosion and deposition of continental and alpine glaciers. These glaciations stripped the bulk of the residual soil, weathered rock, and the earlier glacial deposits from uplands leaving broad areas of essentially bare, fresh rock. Till and other glacial drift was deposited in many areas, but usually as only a thin veneer. In a few places, notably in the lee of major uplands, in sharp indentions within the rock, and along the margins of major valleys, thick deposits of glacial drift have accumulated. Following retreat of the ice, normal processes of weathering and erosion resumed. This has modified the glacial terrain by the deposition of alluvium along the stream courses, down-cutting by the more major streams to form pronounced valleys or gouges, and formation of a thin soil profile (generally less than 0.6 meters [2 feet] thick, average) in those areas below timberline (about 600 meters [2000 feet]).

As a result of this geologic history and the youthfulness of the terrain, valley sides are often very steep. In fact, it is quite common for the slopes to be too steep for the soil that is forming on them to remain in place. This results in frequent, naturally occurring landslides that often take the form of debris avalanches or flows. These landslides are often triggered by blowdown of trees during wind storms.

Most major streams flow in pre-existing bedrock valleys, but the specific location of tributary streams is often controlled by the joint and fault patterns in the rock. Stream gradients are highly variable in response to the frequently "benched" topography of the valley sides. Abrupt changes from gentle or moderate gradients (less than about 20 percent) to a precipitous gradient (about 90 percent to waterfalls) occur frequently. Major rivers have generally deposited substantial quantities of sediment into the fjords (near their mouths) to create extensive low-lying land areas. The rivers have braided or meandering channels in their lower reaches, typically for a distance of at least several kilometers.

As noted, the soil cover over rock in the project region is not well developed and is often quite thin. The soils seem to have formed partly as a result of weathering of a thin veneer of ablation till and the native rock, and partly by the accumulation of organic debris due to the growth, death, and decay of vegetation. The most common soil type in the project region appears to be a highly organic silty sand with varying contents of gravel, cobbles, and larger rock pieces. In general, these soils appear to be somewhat thicker in the more moderate slope areas. This is probably a result of downslope creep and other mass wasting processes moving the soils down from the steeper terrain segments.

In level to moderately sloping terrain areas, extensive muskeg deposits have accumulated. Muskegs are composed of various combinations of sphagnum peat, sedge peat, and muck. They are saturated with water throughout the year and range in thickness from less than 0.6 meters (2 feet) to more than 12 meters (40 feet). Observations suggest that their thickness does not normally exceed 3 or 3.6 meters (10 or 12 feet) maximum within the project region (Appendix B). Some thicker deposits may be present, however.

Previous road construction experience in this type of terrain has indicated that the surficial soils overlaying bedrock are highly susceptible to disturbance and not suitable for road building or construction purposes. This is expected in view of the high organic content of the soils and the fact that they are usually in a saturated condition. Any disturbance and/or exposure to additional water (which is usually abundantly available) commonly leads to severe loss of strength or liquefaction. This soil instability also leads to a high frequency of slumping and landslides on slopes greater than about 66 percent (Swanston 1970).

Each road alternative will encounter a variety of soil types. The Blossom route traverses predominantly sidehill terrain with thin unstable soils. At the seaward end of the Blossom route, the road traverses the Wilson River delta on relatively stable, granular soils while at the upper end it traverses flat terrain with muskeg deposits. The Keta route traverses relatively stable, deltaic and floodplain deposits of the Keta River containing 60 to 70 percent gravel and cobble for roughly half of its distance. Most of the remainder traverses sidehill terrain with thin organic soils or talus deposits and crosses numerous avalanche tracks. Thicker deposits of glacial till are found along the Hill Creek valley. Some muskeg terrain is crossed by the upper portion of the Keta route. Appendix B provides a more detailed discussion of soil and terrain features associated with the alternate road routes.

3.3.2 Vegetation

VTN (1980d) identified six vegetation types and 17 subtypes in their Quartz Hill study area (Table 3-1). Figure 3-1 illustrates the distribution of major types in relation to proposed project facilities. Spruce-hemlock forest is the dominant vegetation in the project area, occurring from sea level up to 760 meters (2,500 feet) in elevation and covering about 50 percent of the land area (VTN 1980d). Other vegetation types exist where conditions of altitude, drainage, slope stability, or local climate prevent the establishment of coniferous forest. Low growing alpine heath or meadow occurs at higher elevations and covers about 20 percent of the land area. Muskeg or bog is relatively extensive with a coverage of greater than 10 percent and occurs on level, poorly drained terrain. Fairly extensive areas of subalpine, transition vegetation occur at altitudes from 370 to 760 meters (1,200 to 2,500 feet), consisting of various combinations of subalpine forest, heath and meadow (VTN 1980d).

TABLE 3-1

CLASSIFICATION OF THE VEGETATION IN THE QUARTZ HILL STUDY AREA

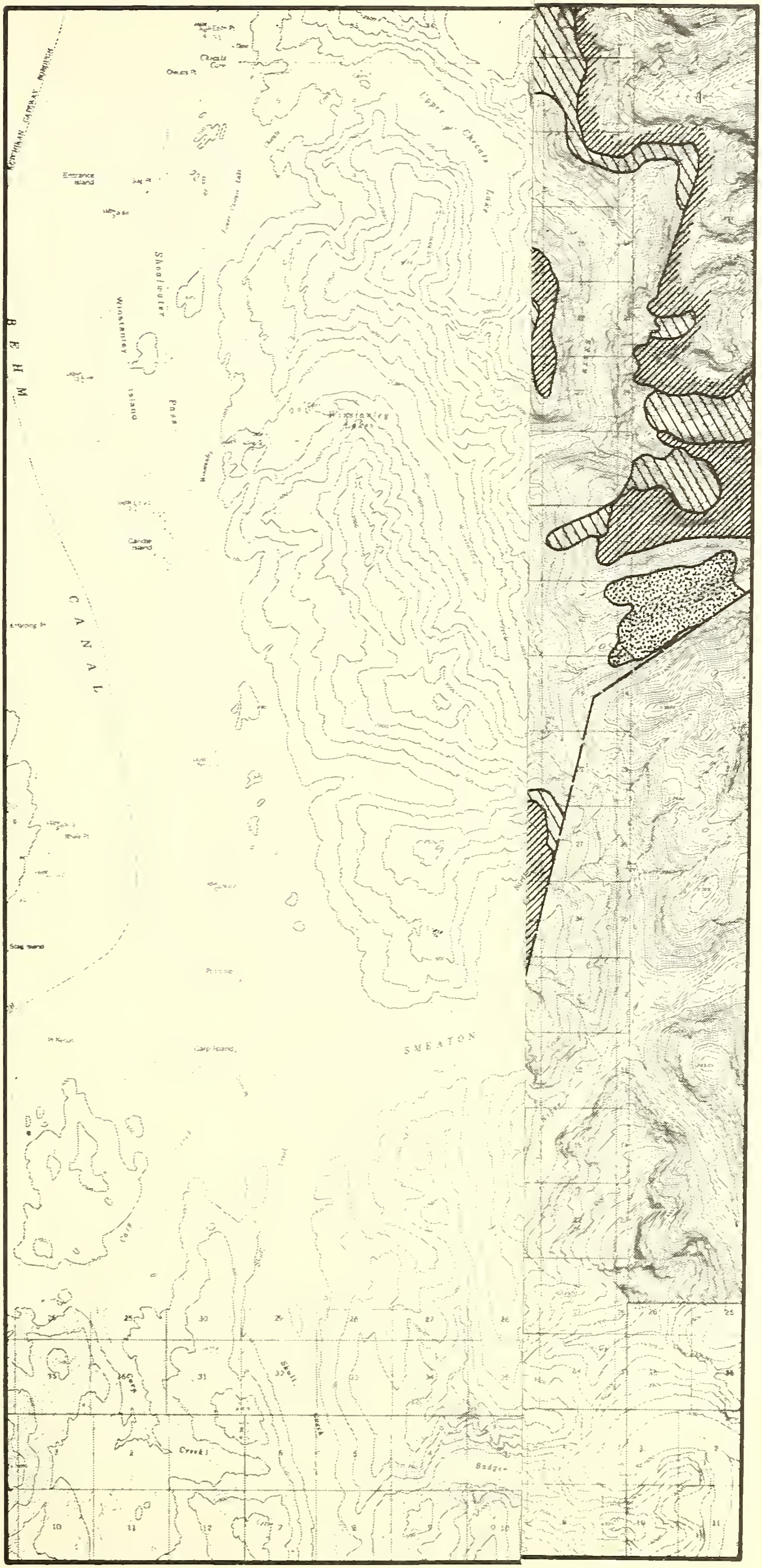
Type	Subtype	Association(a)	Representative Area
Forest	Well-drained Forest	Sitka spruce-Western hemlock/ Devil's club-Blueberry/Bunchberry	Wilson Townsite Adjacent to Keta Estuary
		Western hemlock-Sitka spruce/ Blueberry-Ferns/Bunchberry	Wilson Townsite Adjacent to Blakewell Estuary
		Western hemlock-Sitka spruce/ Salmonberry-Ferns/Bunchberry	Beaver Creek Upper Tunnel Creek
	Poorly-drained Forest	Western and Mountain hemlock-Red and Yellow Cedar/Blueberry/ 5-leaf bramble-Bunchberry-Skunk cabbage	Upper Tunnel Creek Beaver Creek Upper Aronitz Creek White Creek Hill Creek North Ridge Fuel Cache Bakewell
	Deciduous Forest	Red alder/Elderberry-*Ribes*	Adjacent to Keta Estuary
		Red-oiser dogwood/Devil's club - *Ribes*	Wilson townsite
	Open Forest	Red & Yellow Cedar-Western & Mountain hemlock/Blueberry/ Crowberry-*Cassiope*/*Sphagnum*	Fuel Cache Bear Meadow
Bog (Muskeg)	Forested Muskeg	Mountain hemlock-Cedar spp./Blueberry-*Carex*/Deer cabbage/*Sphagnum* Sphagnum	Fuel Cache Bakewell Lowland Bear Meadow North Meadow
		Lodgepole Pine-Western Red Cedar/ Labrador tea/Blueberry-*Carex*/*Sphagnum*	Bakewell Lowland
	Herbaceous Muskeg	Bog laurel-Labrador tea/*Carex-Elocharis*/Crowberry/*Sphagnum*	Bear Meadow Quartz Hill Bakewell Lowland North Meadow
		Carex-Cottongrass/*Sphagnum*	Beaver Creek North Meadow
Subalpine	Subalpine Forest	Mountain Hemlock/Copperbush blueberry/Deer cabbage-*Cassiope*	Alpine above Bakewell East Ridge
		Mountain Hemlock-Yellow & Red Cedar/ Copperbush-Blueberry/Deer Cabbage-*Cassiope*	Quartz Hill
	Subalpine Meadow	Deer cabbage/*Cassiope*	Quartz Hill North Ridge Upper Hill Creek
		Cassiope-*Phyllodoce*/Lichens	Aronitz Ridge North Ridge Alpine above Bakewell Arm
		Bluejoint-Tickle grass-Mountain Timothy	Upper Raspberry Creek
Alpine	Krummholz Forest	Mountain hemlock/Copper bush Deer cabbage/*Cassiope*	Aronitz Ridge East Ridge Alpine above Bakewell Arm

TABLE 3-1
(Continued)

Type	Subtype	Association[a]	Representative Area
	Alpine Heath	Leutkea-Cassiope	Aronitz Ridge Alpine above Bakewell Arm East Ridge
	Alpine Meadow	Canadian bluejoint-Carex-Deer cabbage/Dwarf blueberry-Lichens	East Ridge
		Copperbush/Canadian bluejoint	Aronitz Ridge
Estuary	Estuarine Meadow	Lyngybei sedge/Silverweed	Wilson Estuary Keta Estuary
		Carex-Canadian bluejoint/Silverweed-Goosegrass	Bakewell Estuary
	Coastal Meadow	Dunegrass	Wilson Esutary Keta Estuary
		Sitka willow	Wilson Flats Keta Estuary
		Yarrow-Cow Parsnip/Canadian bluejoint-Hairgrass/Bedstraw	Keta Estuary Wilson Estuary
Riparian	Low Elevation	Red alder/Stink currant-Devil's Club	Tunnel Creek Valley Lower Keta River
		Red osier dogwood/Elderberry	Lower Blossom River
		Sitka willow	Lower Keta River Lower Blossom River
		Red alder-Sitka willow/Currant-Salmonberry	Keta Estuary
	High Elevation	Sitka willow-Barclay willow	Upper Hill Creek Upper White Creek
		Sitka alder-Sitka willow/Cow Parsnip-Devil's Club/Ferns-Fireweed	Hill Creek
Other	Avalanche Chute	Sitka willow-Alder	Upper Hill Creek Tunnel Creek Valley Aronitz Creek Valley
		Elderberry-Cow Parsnip/Salmonberry-Devil's Club Ferns	Upper Hill Creek Tunnel Creek Valley Aronitz Creek Valley
	Freshwater Marsh	Carex-Burnet/Hairgrass-Deer cabbage	Beaver Creek
		Sitka sedge	Wilson Townsite

(a) Tentative

Source: VTN 1980d



LEGEND

▨ ALPINE

▧ SUBALPINE/AVALANCHE SCRUB

░ MUSKEG

○ FOREST

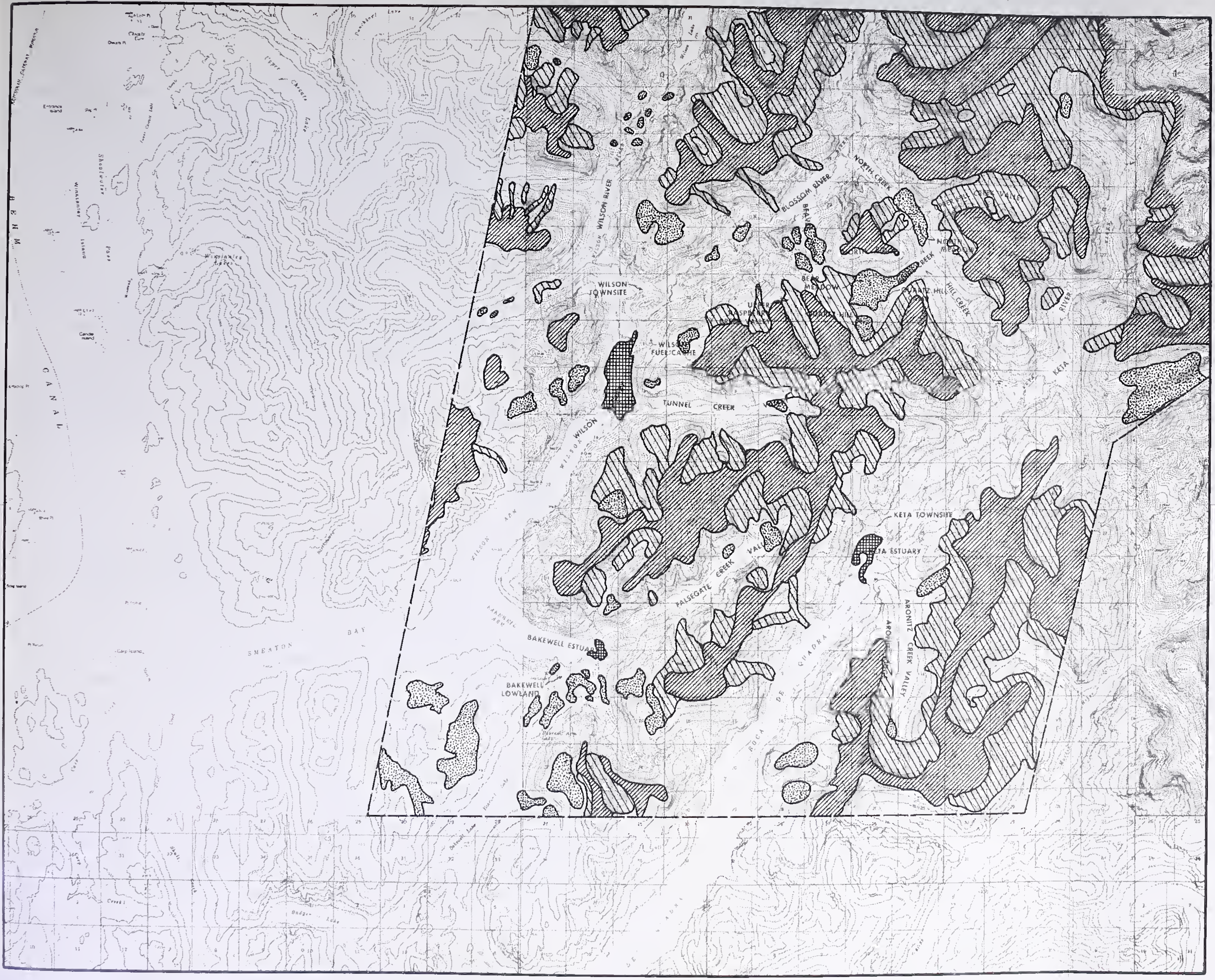
▦ ESTUARY

— — STUDY AREA BOUNDARY

SOURCE: VTN 1980 FIELD STUDIES

VEGETATION MAP

Figure 3-1



SOURCE: VTN 1980 FIELD STUDIES

VEGETATION MAP

Figure 3-1

More specialized vegetation occurs in limited areas. Riparian (streamside) vegetation is found in a narrow zone along major streams and many smaller creeks and consists primarily of red alder forest grading into Sitka alder-willow shrub at higher elevations. Estuarine meadows containing salt-tolerant vegetation (primarily grasses and sedges) are found at the heads of Wilson Arm and Boca de Quadra. Areas periodically disturbed by avalanches are prevented from reaching the mature forest stage and are generally covered with scrub vegetation. A few small areas of freshwater marsh occur in backwater areas of rivers or creeks (VTN 1980d). The floodplain environments adjacent to the Wilson, Blossom and Keta Rivers support a variety of vegetation types in close proximity and, by virtue of this diversity, may be conveniently considered a habitat type of their own.

Vegetation types and subtypes within the road corridor and other bulk sample activity sites are described in detail in Sections 4.2.2.1 and 4.3.2.1.

3.3.3 Wildlife

Studies by VTN (1980d) detected 12 species of mammals, 63 bird species, and one amphibian species. Of these animals, certain key species or species groups were selected as being particularly important from the standpoint of environmental management because of their vulnerability to impact. Key species included mountain goat, black bear, brown bear, bald eagle, waterfowl, water-related birds and marine mammals (VTN 1980d). Other animals of ecological or economic significance include wolf, wolverine, marten, river otter, beaver, mink, Sitka blacktail deer, blue grouse, and ptarmigan.

Mountain goats are common in the Quartz Hill area, generally spending the summer months at and above treeline and descending to lower elevations in the fall, winter or spring in response to snowfall or availability of forage. Annual goat surveys have been conducted since 1968 (ADF&G 1980). Survey results for the area between Boca de Quadra and Wilson Arm, including Quartz Hill (ADF&G Area K-4) are presented in Table 3-2. The surveys provide an index of abundance only and do not indicate absolute populations. Goat

TABLE 3-2

GOAT COMPOSITION SURVEYS WILSON ARM TO BOCA DE QUADRA 1968-1980
(Alaska Department of Fish and Game Goat Survey Area K-4)(a)

YEAR	SURVEY DATE	ADULTS	KIDS	UNKNOWN	TOTAL	KIDS: 100 ADULTS	SURVEY TIME	GOATS/HR.
1968	Sept. 17	193	72		265	37	80 min.	199
1971	Sept. 15	155	56	9	220	36	70 min.	189
1973	Aug. 16	90	13		103	14	65 min.	95
1974	Aug. 27	26(b)	8(b)		34(b)	31	36 min.(b)	57
1975	Aug. 12	15	3		18	20	47 min.	23
1976	Sept. 1	18	7		25	39	57 min.	26
1977	Sept. 6	39	19		58	49	56 min.	62
1978	Sept. 9	65	19		84	29	51 min.	99
1979	Sept. 3(c)	44	16		60	36	65 min.	55
1980	Aug. 27	35(b)	18(b)		53(b)	51	42 min.(b)	76

(a) Source - ADF&G 1980.

(b) Incomplete surveys.

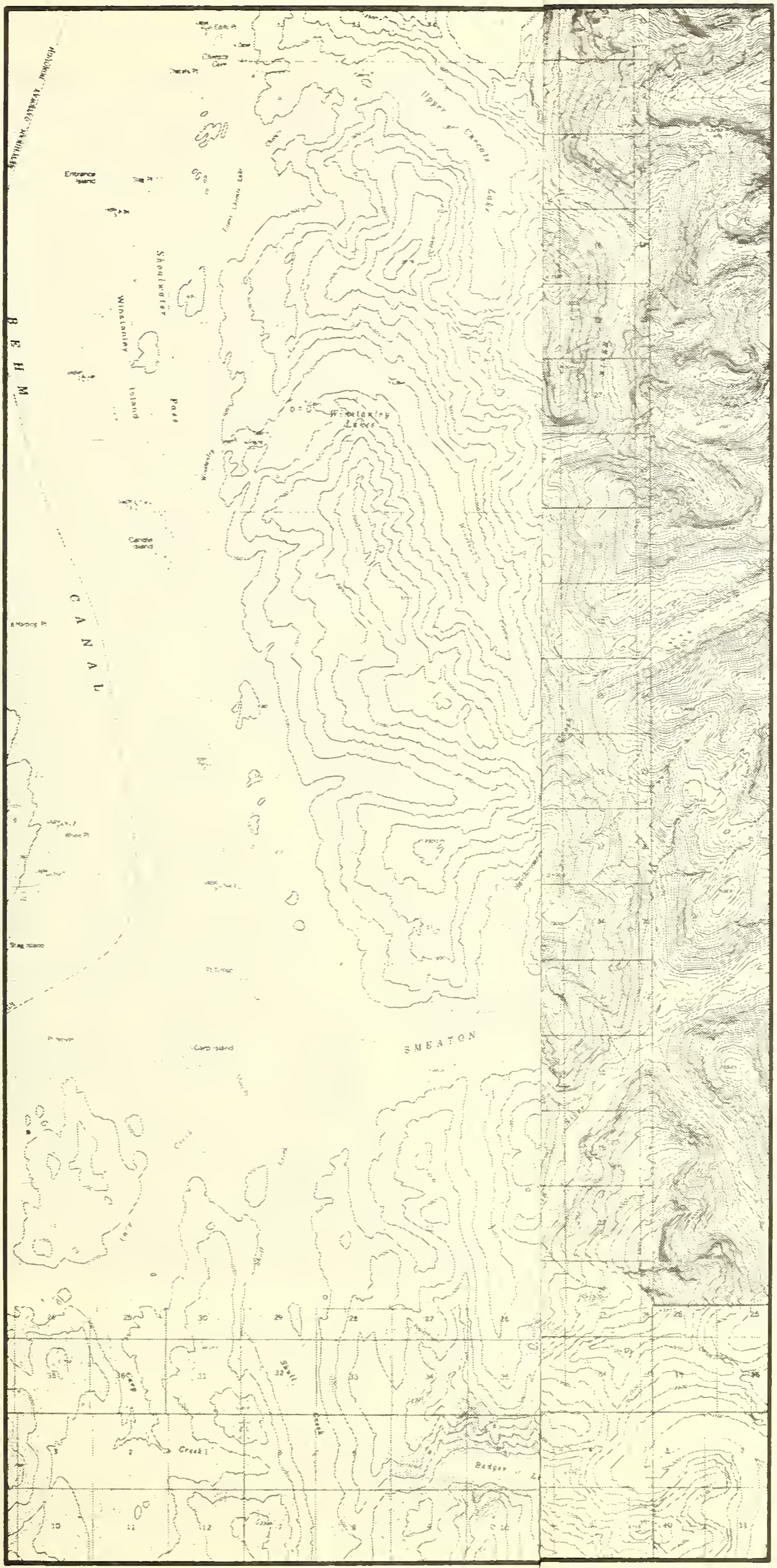
(c) Different observer.

populations apparently declined from a high in the mid-1960's to a low in 1975, then increased to moderate levels in 1980. It has been suggested that the K-4 area could support a population of 200 to 250 goats (ADF&G 1980). In August of 1980, VTN observed 83 goats in their study. The VTN study area is somewhat larger than the Alaska Department of Fish and Game K-4 area (Figure 3-2).

Black bear is one of the most conspicuous large mammals in the project area (VTN 1980d). Habitat use varies somewhat from season to season with emphasis on lower river areas during salmon spawning in July and August. However, even during August 1980, black bears were found throughout the project area. Fifteen black bears were sighted by VTN in their study area in June and 19 in August of 1980 (Figure 3-2). Additionally, the Wilson/Blossom confluence area was probably used by small numbers of brown bear, based on a limited number of unconfirmed sightings (VTN 1980d). A brown bear was sighted on the Keta estuary in June 1981 (Dames & Moore field data).

Several species of marine mammals use both Wilson Arm and Boca de Quadra. Concentrations of harbor seals occur at the mouths of the Wilson and Keta Rivers during salmon runs, and the steep shorelines of these areas are used as seal pupping areas (ADF&G 1980). Whales and porpoises may be found in the area in the summer months.

Bald eagles are seasonally common in the Quartz Hill vicinity. The special protective status accorded the bald eagle by the Bald Eagle Act of 1940 has created particular concern for this species. Nest surveys, conducted by the U.S. Fish and Wildlife Service and VTN, indicate at least eight nest sites along Wilson Arm and Wilson estuary and seven sites along Boca de Quadra and the Keta estuary (VTN 1980d, Figure 3-3). No inland sites were found. The proportion of active nests has not been accurately determined but is probably less than 25 percent. In addition to nesting activities, bald eagles concentrate in both the Wilson and Keta estuaries in the late summer and fall to feed on spawning salmon. Groups of up to 50 birds were observed in August 1980 by VTN (1980d). The eagles frequent the marine interface area and lower reaches of the major rivers. Use of higher altitude terrain is uncommon.



LEGEND

▲ MOUNTAIN GOAT - JUNE

♦ MOUNTAIN GOAT - AUGUST

■ BLACK BEAR - JUNE

● BLACK BEAR - AUGUST

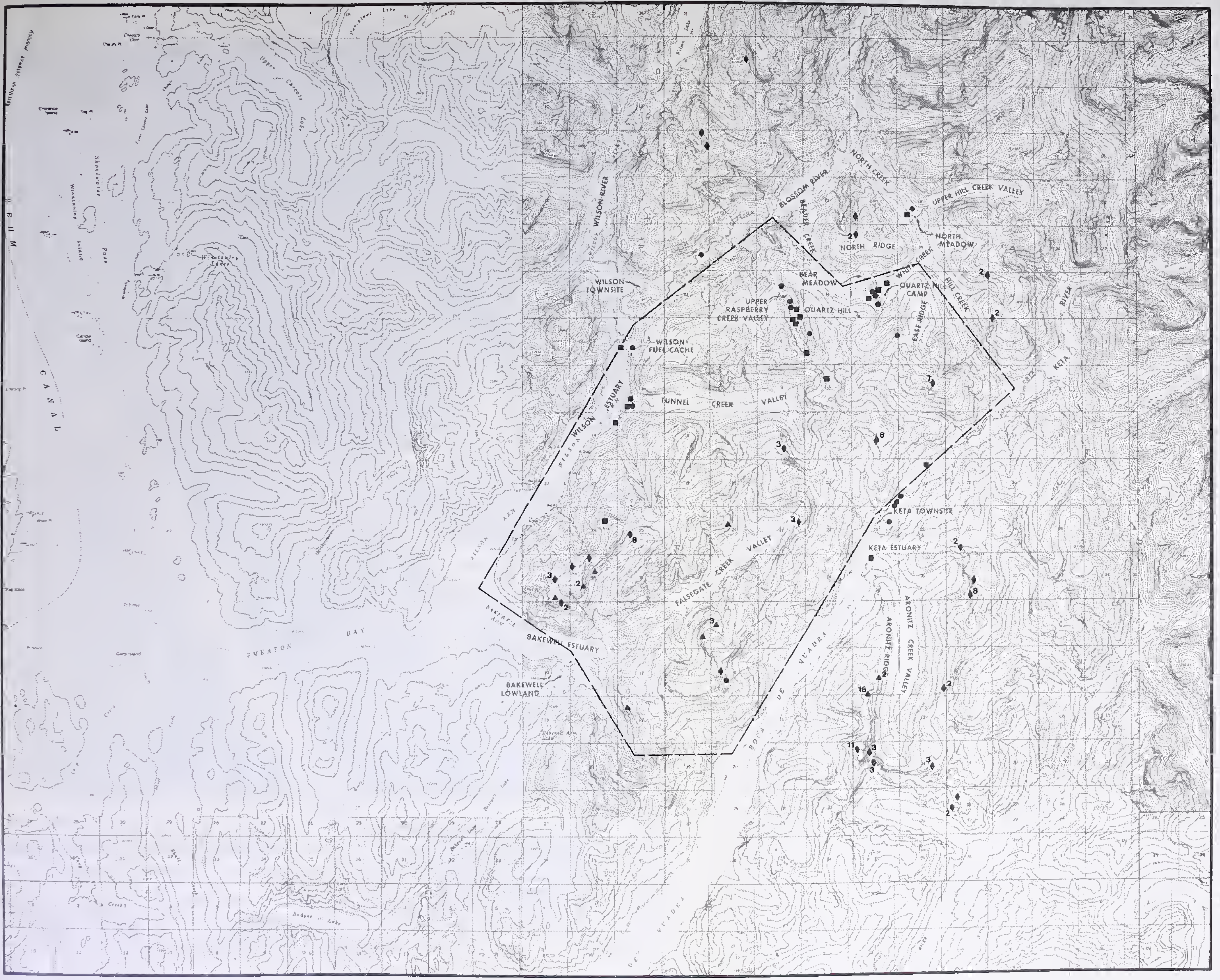
9 NUMBER OF INDIVIDUALS IF MORE THAN ONE

NOTE:
THE ADFG MOUNTAIN GOAT SURVEY AREA K-4 IS WITHIN THE OUTLINED AREA

SOURCE: VTN 1980 FIELD STUDIES

LOCATIONS OF MOUNTAIN GOAT AND BLACK BEAR SIGHTINGS

Figure 3-2

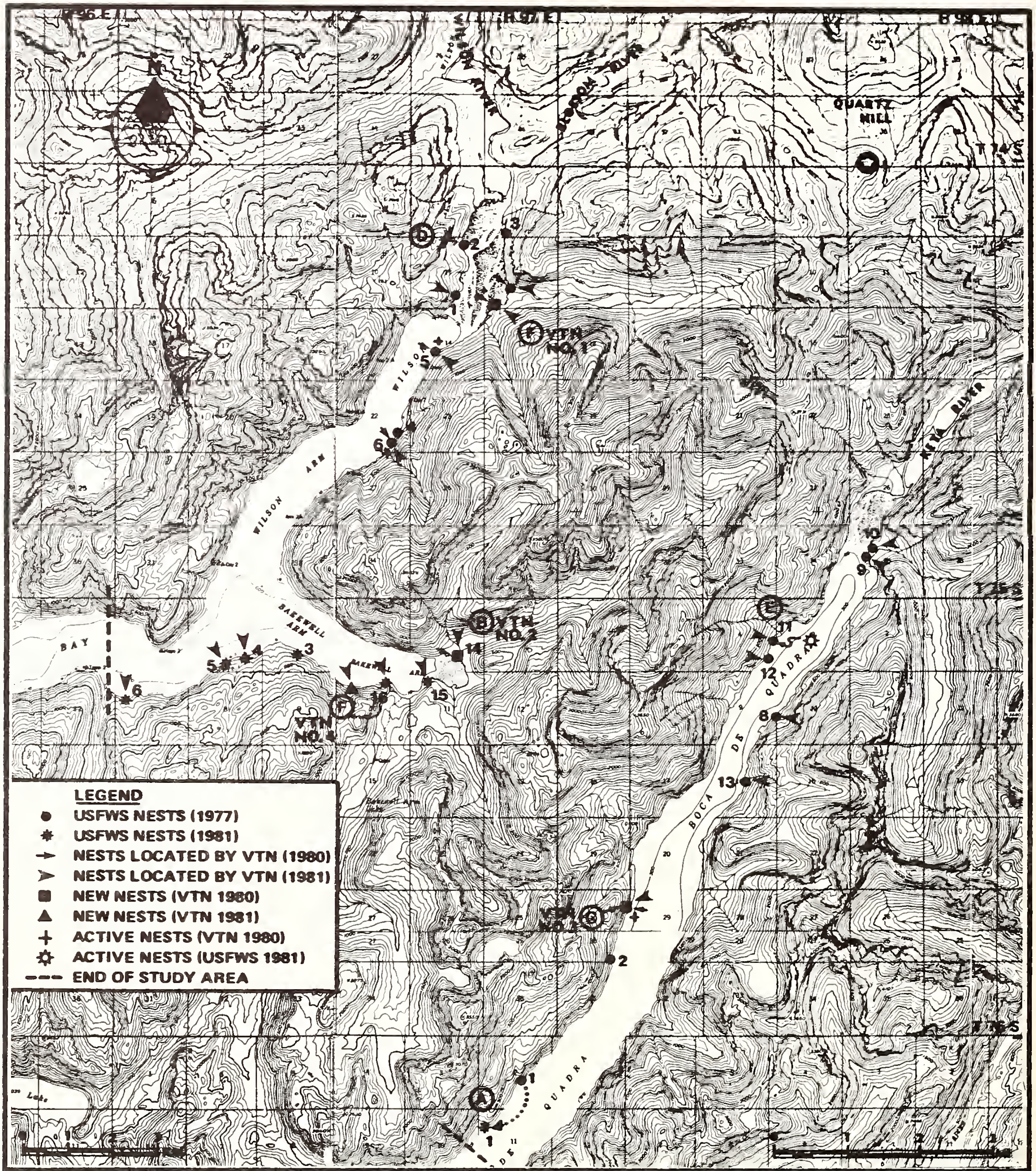


NOTE:
THE ADFG MOUNTAIN GOAT SURVEY AREA K-4 IS WITHIN THE OUTLINED AREA

SOURCE: VTN 1980 FIELD STUDIES

LOCATIONS OF MOUNTAIN GOAT AND BLACK BEAR SIGHTINGS

Figure 3-2



NOTES:

NEST NUMBERS ARE USFWS DESIGNATIONS

A. LOCATION CHANGED BY USFWS

B. LOCATED BY USFWS 1981 = USFWS NO. 14

C. MAY BE SAME AS USFWS NO. 2

D. NEST DESTROYED (VTN 1981)

E. NOT ACTIVE DURING VTN 1981 SURVEY

F. NESTS NOT ON USFWS MAPS (1981)

LOCATIONS OF BALD EAGLE NESTS

SOURCE: USFWS 1977, 1981
VTN 1980, 1981 FIELD STUDYS

Figure 3-3

Modest numbers of waterfowl use the Wilson and Keta estuary areas during the summer (VTN 1980d). Primary species observed were mallard, merganser, Canada geese, and pintail. Relatively low numbers of other water-related birds (loons, grebes, herons, shorebirds, sea ducks and gulls) also use the nearshore saltwater habitats in summer (VTN 1980d). The numbers and kinds of birds observed were similar for the Wilson and Keta estuaries. It should be noted that studies of bird use of the estuary during spring, fall and winter begun in 1981 have not yet been reported and data is limited. Estuarine areas are often valuable to migratory waterfowl, shorebirds, and other groups of birds in spring and fall. Canada geese, mallards, sea ducks, and swans have been observed in both estuaries during the winter. The Keta River estuary frequently freezes in the winter, restricting waterfowl use (ADF&G 1981).

3.3.4 Habitat Value and Sensitivity

The dominant spruce-hemlock habitat supports important wildlife populations including black and brown bear, wolf, pine marten, and blue grouse. As indicated in Table 3-1, the forest is comprised of several subtypes and wildlife use is not uniform. Uneven age stands of mature coastal forest at low elevation and on level terrain are potentially important wintering areas for Sitka black-tailed deer. However, only a few deer have been observed in the project area and current use is light. It can be expected that mountain goats use some portion of the coniferous forest. Goats in southeast Alaska often move from alpine and subalpine areas to forested areas to escape heavy snowfall or take advantage of the earlier availability of vegetation growth at lower altitudes in the spring (Schoen et al. 1980). The behavior of goats has not been specifically investigated in the Quartz Hill area; therefore, extent and altitude of forest use is not known. Studies recently initiated on the Cleveland Peninsula near Ketchikan indicate some use of forested habitat even during the mild 1981 winter (Smith 1981). Coniferous forest is by far the most extensive habitat, suggesting that disturbance of portions of the forest would have somewhat less impact to regional wildlife populations than would disturbance to other more limited habitats. However, some subhabitats would be expected to have greater value than others and special wildlife use areas such as wildlife movement corridors or goat winter habitats would be very sensitive.

Alpine and subalpine habitats are less extensive and probably more sensitive to disturbance than the coniferous forest. These habitats are used by mountain goat and black bear, both key species. Recovery of alpine vegetation following disturbance is often slow.

The most sensitive and/or most valuable habitats within an area are often those of very limited extent or that provide a particular life requisite for an animal species. The Wilson and Keta estuarine areas (including the lower river valleys) are particularly important to wildlife because of the habitat diversity. Additionally, the seasonal availability of spawning salmon provides a food source for several wildlife species and supplies a substantial energy input to the ecosystem. Floodplains and their associated riparian zones also provide habitat diversity and a food source for wildlife. The Keta, Blossom, and Wilson valleys as well as the zones adjacent to some of the major tributaries would be expected to provide important habitat.

3.3.5 Wetlands

It has been nationally recognized that wetland habitats are a particularly valuable ecological resource and an integral part of regional hydrological regimes. Because of these special values and vulnerability to development activity, wetlands were granted special regulatory status via Section 404 of the Clean Water Act of 1977. This act delegates authority to the U.S. Army Corps of Engineers and EPA to manage wetland alteration activities through a permit system. Wetlands are treated as a separate section in this report in order to achieve emphasis commensurate with these special values and regulations. Wetlands are defined by regulations (33 CFR 323.2 Para. c) as follows:

> "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support and that under normal

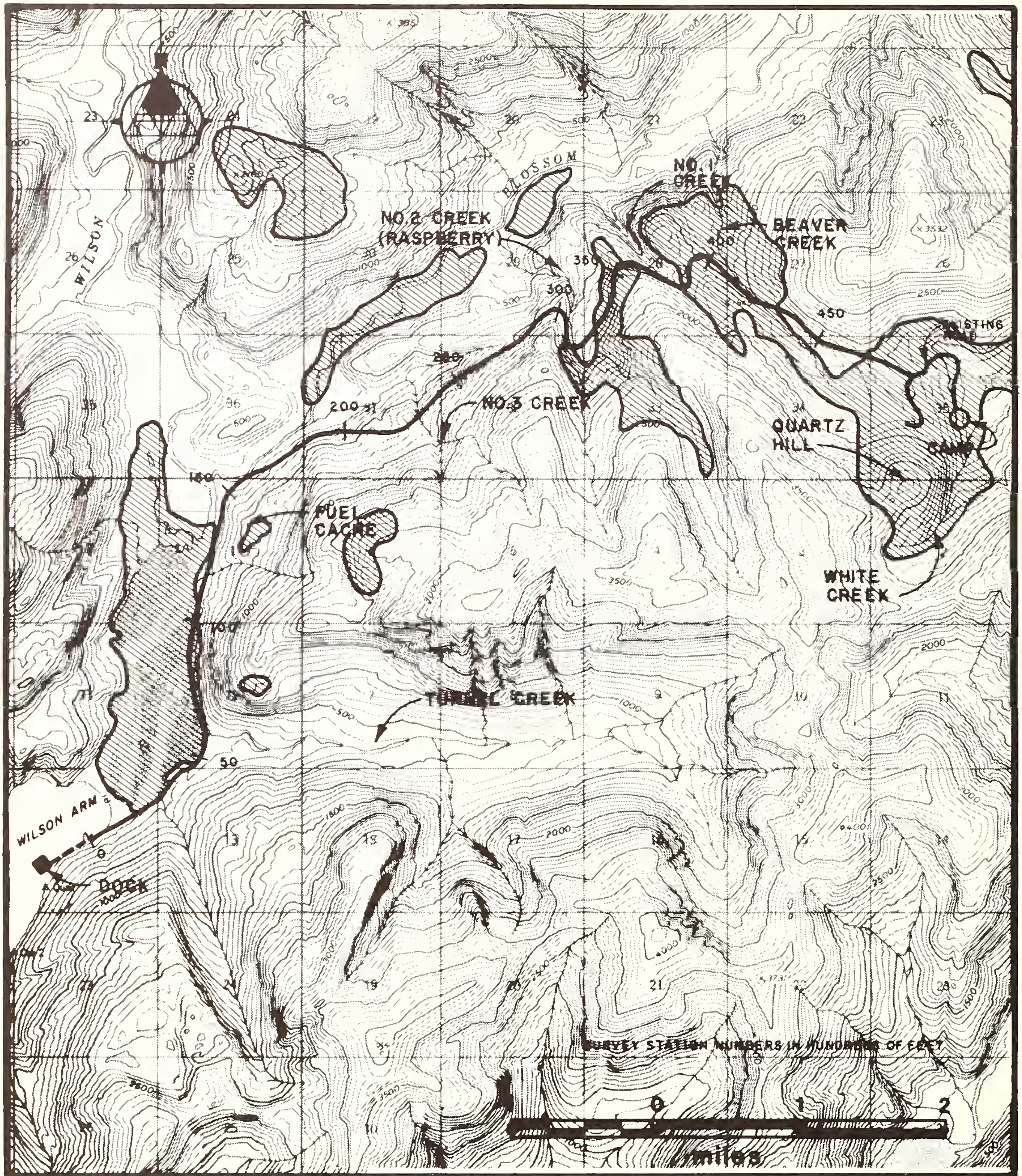
circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Three major kinds of wetlands would be affected by the alternative access road routes and bulk sampling facilities: estuarine salt marsh on the Wilson or Keta deltas, muskeg along various portions of either road route and rocky intertidal area in the vicinity of the marine facilities on either Wilson Arm or Boca de Quadra. Riparian habitats adjacent to some of the streams may also be considered wetlands. Major wetlands (marsh and muskeg) are delineated on Figures 3-4 and 3-5. These areas were delineated through the use of aerial photos and through interpretation of the VTN (1980d) vegetation mapping. Numerous unmapped small wetland areas, primarily of the muskeg type, would be traversed by either access route and will have to be identified through field survey.

Based on legislative requirements (40 CFR 230) and scientific analysis, wetland values in the Quartz Hill area are viewed in four broad categories. The following is a discussion for each of the value categories in order to provide a basis for assessing the wetland impacts that could result from the proposed activities.

3.3.5.1 Food Chain Production

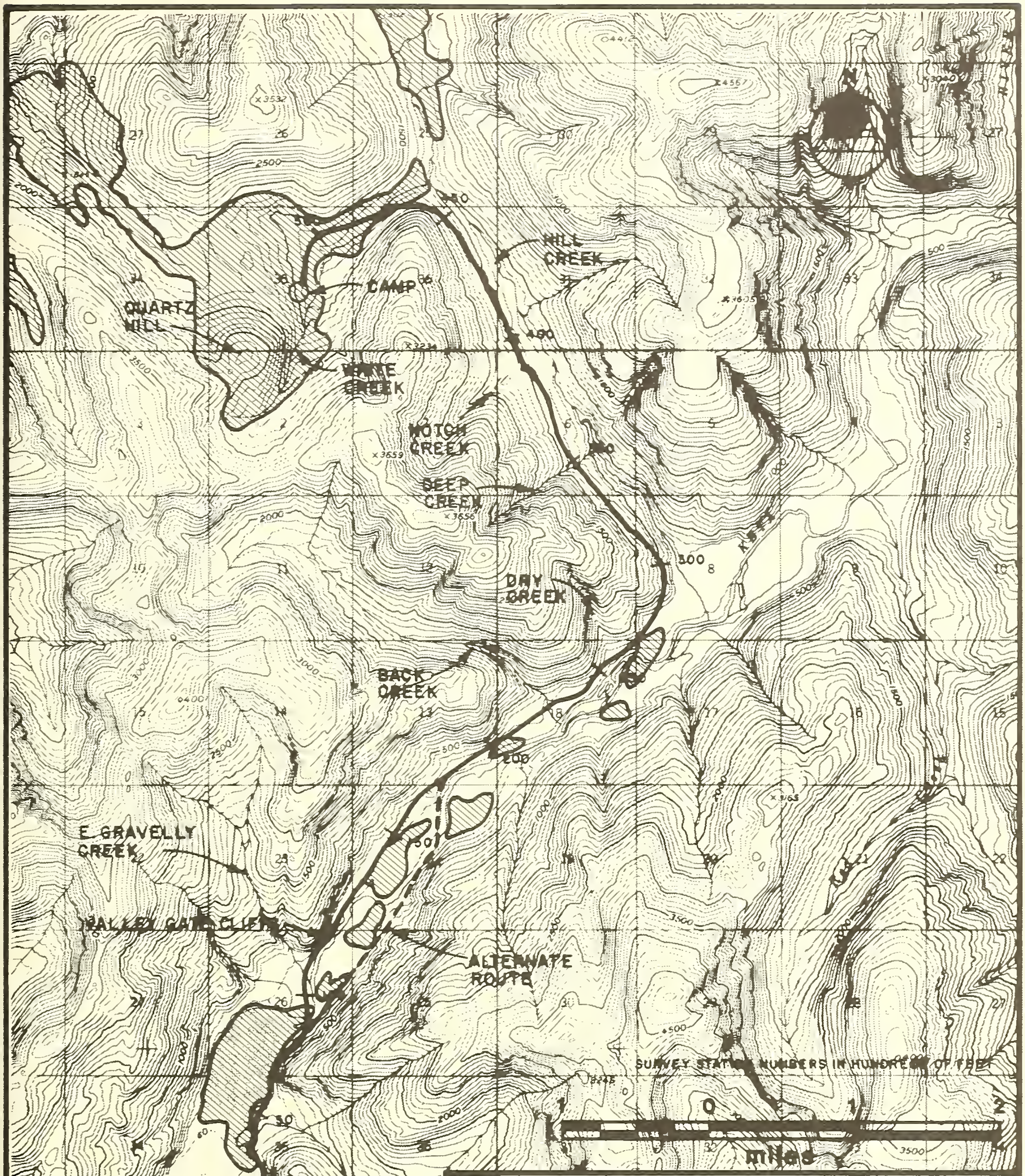
Salt marshes are known to be highly productive of plant matter in relation to other kinds of biological systems (Darnell et al. 1976). It can be assumed that the estuarine meadows on the Wilson and Keta River deltas (130 hectares [320 acres] and 80 hectares [200 acres] respectively) are productive and ecologically important. The wildlife use documented by VTN (1980d) would tend to confirm this assumption. The plant matter produced enters the food chain in a number of ways. Some animals such as insects and other invertebrates, bears, and waterfowl feed directly on the vegetation. A portion of the marsh vegetation dies and is washed by tides into the marine environment where it contributes to the organic matter on the sea bottom. This organic matter supports a variety of bottom dwelling organisms including commercially important shellfish. Energy produced within the marsh makes a



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

WETLANDS MAP
BLOSSOM RIVER AND QUARTZ HILL

Figure 3-4



WETLANDS MAP
KETA RIVER

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

Figure 3-5

major contribution to the foodweb within the intertidal zone. Juvenile salmon in the intertidal channel complexes feed on crustaceans and insects that derive their energy from plant matter (see also Section 3.5.1).

Muskeg type wetlands are substantially less productive than the salt marsh type. Nevertheless, they contribute significantly to local food webs. Black bears feed in muskeg areas because of the presence of preferred plant species (VTN 1980d). Song birds inhabiting the forest edge move to wetlands to feed on invertebrates.

3.3.5.2 Habitat for Land and Aquatic Species

Waterfowl, shorebirds and song birds feed and nest on the estuarine meadow habitats. Migratory birds also use these areas as sanctuaries and feeding grounds. Black and brown bears feed on selected plant species (VTN 1980d). Aquatic animals including juvenile salmon inhabit the intertidal channels of both the Keta and Wilson deltas and may venture over the marsh areas during high tides. Some salmon spawn in the intertidal zone.

Muskeg habitats provide openings in predominately forested terrain and, therefore, are often used by animals such as bears as travel corridors. Song birds frequently nest at the forest edge adjacent to the muskeg areas.

3.3.5.3 Hydrology and Water Quality

Muskeg type wetlands play an important role in the storage of water. The shallow soils underlain by bedrock in the Quartz Hill area tend to cause water from precipitation to run off quickly. Muskeg areas tend to buffer this runoff, reducing flood probabilities and providing a source for recharge of groundwater supplies. This storage capacity helps to assure year-round flow in the major river systems and prevent extreme fluctuations. Successful incubation of salmon eggs in stream gravels depends on this continued flow.

Both salt marsh and muskeg wetlands can contribute to flow of nutrients within freshwater and marine environments. Chemical reactions that occur during the process of decay within organic matter underlying wetlands cause nutrients such as nitrates to be released into the water. Surface drainage distributes these nutrients to aquatic habitats.

3.3.5.4 Recreational Use

Because of the presence of migratory waterfowl and big game animals (bears), the estuarine marsh areas at the heads of Wilson Arm and Boca de Quadra provide substantial opportunities for hunting. The Wilson estuary "receives fairly heavy hunting pressure in the fall" by area residents (ADF&G 1980), while the Keta River delta is lightly hunted because of its inaccessibility. Sport fishing may also be oriented around the wetland areas at the river mouths although the activity is not directly dependent on wetlands.

3.3.6 Endangered and Threatened Species

The status of endangered or threatened species in relation to the Quartz Hill Project has been reviewed by VTN (1980d). No threatened or endangered animal species have been observed in the Quartz Hill vicinity. Use by any animals classified as threatened or endangered is unlikely, with the possible exception of the peregrine falcon and the humpback whale. The endangered Arctic and American subspecies of the peregrine falcon nest farther north and could conceivably pass over the project area during migration. The Peale's subspecies of peregrine falcon does breed in southeast Alaska, although none have been observed at Quartz Hill. This subspecies is not classified as endangered. Humpback whales could rarely be found in Smeaton Bay or Boca de Quadra in the summer months.

No plant species within the State of Alaska have been officially classified as threatened or endangered. However, numerous species have been recommended for threatened or endangered status (Murray 1980). None of these species occurs in southeast Alaska or was observed in the Quartz Hill vicinity (VTN 1980d). It should be emphasized, however, that the level of botanical knowledge of the area is rudimentary.

3.4 FRESHWATER ENVIRONMENT

3.4.1 Hydrology

Regional surface hydrologic trends and those of the Quartz Hill area display distinct seasonal patterns with two low flow and two high flow periods. These trends are caused by factors affecting runoff, principally, air temperature and precipitation (see Section 3.2). The lowest annual flow occurs between January and March when precipitation remains close to the annual average. Stream flow declines during this period when the maximum and minimum daily air temperatures drop below freezing and potential runoff becomes stored as ice and snow. This period may also experience peaks in flow when temperatures increase above freezing, but without precipitation. The secondary period of high flow occurs in May and June because of runoff from snowmelt. Subsequently, discharge decreases to the secondary low period in August parallelling the normal decrease in rainfall during June and July. However, occasional rain storms in August may create high discharges approaching the magnitude of discharge during spring breakup and in October. Rainfall increases during the fall, resulting in the highest period of discharge, which usually occurs before October 15. This seasonal trend in discharge applies to both large and small drainage basins, is representative for the entire Quartz Hill region, and is not dependent on elevation.

Runoff peaks in the Quartz Hill area are of short duration and mostly the result of rainfall storms. The watersheds respond quickly to storm events because of their narrow shape, steep topography, shallow soil layer, and high drainage density (ratio of total stream length to drainage area).

Data collected from the Keta River and White Creek indicate that runoff was approximately 0.25 cubic meters per second per square kilometer of drainage area ($m^3/s/km^2$; 9 $ft^3/s/mi^2$) during the 1978 to 1980 data collection period (VTN 1980e). However, runoff during this period was lower than normal when compared to long-term discharge records for Fish Creek near Ketchikan. Regional comparison of the average yearly runoff indicates that 0.36 $m^3/s/km^2$ (13 $ft^3/s/mi^2$) is likely to be representative for streams in the Quartz Hill area (VTN 1980e).

Table 3-3 presents the drainage area and maximum and minimum discharge measured during the period of record (July 1978 through December 1980) for streams in the project area. Values denoted with an asterisk are estimated.

Flood frequency statistics cannot be calculated with a high degree of accuracy, especially the 100-year flood, because of the lack of long-term flow records in the Quartz Hill area. However, estimation of the flood flows from regional data have been completed by the U.S. Forest Service for major streams in the project area (Table 3-3). The drainages in the Quartz Hill area, however, show little evidence of flood damage.

3.4.2 Water Quality

The surface water quality of the Quartz Hill area is pristine and displays minor seasonal and spatial variations. It is characterized as being slightly acidic, very soft, well oxygenated, poorly buffered, and contains low levels of dissolved and suspended solids, nutrients, and total organic carbon.

The major factors influencing surface water quality in the project area are the short residence time between rainfall and runoff, and the flushing of stored water from muskegs. This situation, coupled with the large volume of precipitation, results in a relatively dilute solution.

VTN (1980e) collected 148 water quality samples from 17 surface water stations in the Quartz Hill area from July 1978 to December 1980. No major temporal or spatial trends in water quality were observed. Minor trends did occur, however. For example, pH, conductivity, total dissolved solids, calcium, magnesium, sodium, and potassium levels were inversely related to discharge, which is typical in natural systems. Concentrations of major ions, silica, and iron tended to increase downstream in the Keta River, whereas, concentrations of major ions remained relatively stable at all stations throughout the year in the Blossom River. Also, the Blossom River generally had slightly higher concentrations of most constituents than the Keta River. Smaller drainages exhibited slightly higher concentrations of

TABLE 3-3

MEASURED AND CALCULATED DATA FOR
QUARTZ HILL AREA STREAMS

Stream	Drainage Area, Km^2(Mi^2)	Calculated Flows, m^3/s (ft^3/s)(d) 25-Year	Calculated Flows, m^3/s (ft^3/s)(d) 100-Year	Measured Discharge, m^3/s (ft^3/s)(b) Maximum	Measured Discharge, m^3/s (ft^3/s)(b) Minimum	Calculated 10-Year Winter Low Flows, m^3/s (ft^3/s) On A Seven-Day Average(d)	Calculated Mean Annual Flows, m^3/s (ft^3/s)(d)
Wilson River	292.8 (113)	435.8 (15378)	523.4 (18468)	28.3 (1000)	4.5 (160)	2.52 (88.8)	28.2 (994)
Blossom River	187.8 (72.5)	360.1 (12708)	434.8 (15343)	715.31 (25200)(c)	3.5 (124)	1.14 (40.2)	17.2 (606)
North Creek	4.4 (1.7)	------	-----	0.56 (19.9)	0.006 (0.23)	-----	-----
Beaver Creek	6.5 (2.5)	21.2 (749)	25.4 (897)	1.09 (38.4)	0.08 (2.86)	0.02 (0.6)	0.6 (20)
Beaver Creek, at Bridge Site	1.0 (0.4)	2.7 (94)	3.3 (115)	-----	-----	0.001 (0.04)	0.1 (3)
Raspberry Creek	8.6 (3.3)	25.5 (899)	30.5 (1078)	-----	-----	0.02 (0.8)	0.7 (26)
Raspberry Creek, at Bridge Site	6.7 (2.6)	17.1 (605)	20.9 (737)	-----	-----	0.02 (0.6)	0.6 (20)
No. 3 Creek	3.9 (1.5)	12.6 (446)	15.1 (534)	-----	-----	0.01 (0.3)	0.3 (11)
No. 3 Creek, at Bridge Site	1.8 (0.7)	5.9 (208)	7.1 (252)	-----	-----	0.002 (0.1)	0.1 (5)
Tunnel Creek	26.4 (10.2)	------	-----	3.08 (109)	0.35 (12.3)	-----	-----
Falsegate Creek	38.6 (14.9)	------	-----	7.07 (250)	0.49 (17.4)	-----	-----
Keta River	204.6 (79.0)	433.7 (15303)	522.1 (18422)	857.5 (30300)	1.3 (46)	1.48 (52.1)	20.4 (720)
White Creek	7.0 (2.7)	17.3 (611)	21.1 (745)	14.2 (503)	0.06 (2.2)	0.02 (0.6)	0.6 (21)
Hill Creek	37.5 (14.5)	140.0 (4942)	163.0 (5753)	7.76 (275)(a)	0.51 (21)(a)	0.15 (5.4)	3.4 (120)
Aronitz Creek	25.4 (9.8)	63.8 (2252)	76.7 (2705)	7.08 (250)(a)	0.17 (6)(a)	0.10 (3.4)	2.3 (80)

(a) USGS measurements
(b) Measured values only - do not represent actual ranges
(c) U.S.D.A. Forest Service estimate
(d) U.S.D.A. Forest Service computer calculations

Sources: VTN 1980e; U.S.D.A. Forest Service flood frequency analysis; USGS major constituents than the larger drainages. However, the concentrations and volume of flow from the smaller streams are insufficient to significantly alter the water quality of the lower reaches of the Keta and Blossom Rivers.

Dissolved oxygen remained at or near 100 percent saturation at all sampling stations (VTN 1980e). High oxygen values were measured during winter and spring when water temperatures were low, and lower oxygen levels were measured during summer when water temperatures were at their maximum.

Concentrations of nutrients are low and the system appears to be phosphorus limited. Field pH measurements ranged between 4.5 and 9.1 and the mean was 6.3 pH units (VTN 1980e).

Water temperature exceeded the State water quality standards for growth and propagation of fish, shellfish and other aquatic life on occasion. Baseline values ranged up to 16.5°C (61.7°F) during the salmon spawning period (VTN 1980e), but the standards allow the following maximum temperatures where applicable: migration routes and rearing areas--15°C (59°F), and spawning areas and egg and fry incubation--13°C (55°F; ADEC 1979). A maximum temperature of 20°C (68°F) is acceptable when and where none of the above activities are occurring. The health of existing fish populations suggests that these occasional high temperatures are not significant to fish utilization.

Suspended solids concentrations are low, having ranged from less than 1 to 5 milligrams per liter (mg/l) with an average of 1.3 mg/l (VTN 1980e). Relatively little sediment is available for transport by streams because the thick vegetative cover reduces the erosion potential and because muskeg areas act as sediment traps. Landslides and other mass failures are the primary source for sediment. Subsequent to one of these events, suspended solids concentrations are likely to be quite high.

Most of the trace materials exhibited concentrations that are acceptable for the growth and propagation of freshwater aquatic organisms. Maximum concentrations of cyanide (0.11 mg/l), iron (1.1 mg/l), lead (0.06 mg/l), manganese (0.036 mg/l), and zinc (0.105 mg/l), however, exceed recommended limits for these trace materials (EPA 1976; McNeely et al. 1979). These relatively high concentrations do not imply toxicity but may suggest that limiting levels are being approached. The tolerance of aquatic organisms varies widely between drainage systems. The analytical methods were not sufficiently sensitive to detect the very low levels of cadmium and mercury that could affect freshwater aquatic organisms (cf EPA 1976).

3.4.3 Biology

Four of the five North American species of Pacific salmon are commonly found in the streams of the Quartz Hill area; only sockeye salmon are scarce. All of the salmon species are commercially valuable with pink salmon currently supporting by far the largest fishery in the Ketchikan area. Since many of the small creeks are torrential or contain barriers (e.g., no fish have been found in White Creek), the major rivers contain the primary salmon spawning and freshwater fish habitats. However, the lower reaches of tributary streams, and the side channels of rivers and estuaries are often spawning and rearing areas.

The Blossom and Keta Rivers are approximately equal in available salmon spawning area, contributing 344,000 square meters (m^2; 3.7 million ft^2 and 303,600 m^2 (3.2 million ft^2) respectively (Edgington and Larson 1977). The Wilson River contains 188,000 m^2 (2 million ft^2) of freshwater spawning area above its confluence with the Blossom plus 58,000 m^2 (623,655 ft^2) downstream from the confluence, some of which is in the intertidal zone. Wilson Lake stabilizes the flows of Wilson River, and the river's spawning substrate is less sandy than the Blossom's and is made up of smaller gravel than that of the Keta. Therefore, it has a greater spawning capacity per unit area. Tunnel and Aronitz Creeks have 3,863 m^2 (41,537 ft^2) and 1,655 m^2 (17,795 ft^2) of spawning area, respectively.

Alaska Department of Fish and Game (ADF&G 1980) has ranked Wilson River as the poorest of the three in the quality of freshwater rearing area for chinook and coho salmon fry. The Blossom River was ranked as having the best-quality rearing area. This ranking was based on surveys of tributary streams and beaver ponds, and on trapping of juvenile coho and chinook salmon. The available data indicate that the abundance of juveniles of all salmon species is approximately equal between the Keta and Blossom Rivers (VTN 1979, 1980b).

While there is little current sport fishing for pink or chum salmon that move through Wilson Arm or Boca de Quadra, fish from these populations may be harvested in sport fisheries elsewhere. Both are abundant and of great commercial importance.

Average peak escapements for pink salmon, based on yearly indexing for 1960-1980, are (Edgington and Larson 1977; State of Alaska 1981):

Overall	Keta River	Blossom River	Wilson River
Mean	27,700	24,100	99,100
Range	300-138,100	390-76,000	6,000-286,000
Years of data	21	19	21

Some caution should be observed in interpreting the above data. The Wilson and Blossom Rivers join together about 0.8 kilometer (1/2 mile) from the Wilson estuary with the lower portion considered part of the Wilson River. Fish enumerated in this portion during aerial surveys may have been en route to the Blossom River. Therefore, separation of the Wilson and Blossom Rivers may misrepresent the relative importance of the Blossom River (Cornelius 1981). More accurate data has been obtained in recent years. Escapement for the years 1976 - 1980 suggests a 30 percent higher return for the Blossom than the Keta River.

Although pink salmon escapements fluctuate on an odd-even year cycle, the Wilson River usually receives the greatest return of adults. In the even years since 1960, the Keta's run of pinks has been greater than the Blossom's:

Even Years	Keta River	Blossom River	Wilson River
Mean	45,600	38,500	105,300
Range	3,100-138,100	4,100-76,000	21,000-192,000
Years of data	11	10	10

However, the odd-year pink return has been about the same in the Blossom as in the Keta:

Odd Years	Keta River	Blossom River	Wilson River
Mean	7,900	8,100	92,300
Range	300-34,000	390-45,000	6,000-286,000
Years of data	10	9	10

Pink salmon is the most important commercial species supported by streams in the project area. The Wilson River has been estimated to contribute about 12 percent to the 1.4 million average total escapement of pink salmon in Alaska Department of Fish and Game Reporting Distict No. 1, whereas the Keta and Blossom Rivers each contribute about 2 percent (ADF&G 1979). It should be noted again that the distinction between the Wilson and Blossom Rivers may be somewhat artificial. Pink salmon peak escapement goals for the three rivers are Wilson River 200,000, Blossom River 75,000, and Keta River 120,000 (ADF&G 1980). In other words, it is thought that these rivers could support about 40 percent more spawners on the average than now occurs.

Average peak escapements for chum salmon, based on incidental counts during pink salmon surveys for 1960-1980, are (Edgington and Larson 1977; State of Alaska 1981):

	Keta River	Blossom River	Wilson River
Mean	6,900	1,600	3,400
Range	200-30,000	20-5,000	25-10,000
Years of data	18	11	10

On the average, recorded peak escapements of chum salmon are considerably greater in the Keta than in the Blossom and Wilson Rivers; however, since chum salmon counts were made in conjunction with pink salmon surveys, it is likely that chum salmon within the Wilson River were masked by the large numbers of pink salmon and that chum salmon numbers were underestimated (Cornelius 1981). Evidence to date suggests that the Keta and Blossom Rivers may have both an early and a late chum salmon run (VTN 1980b).

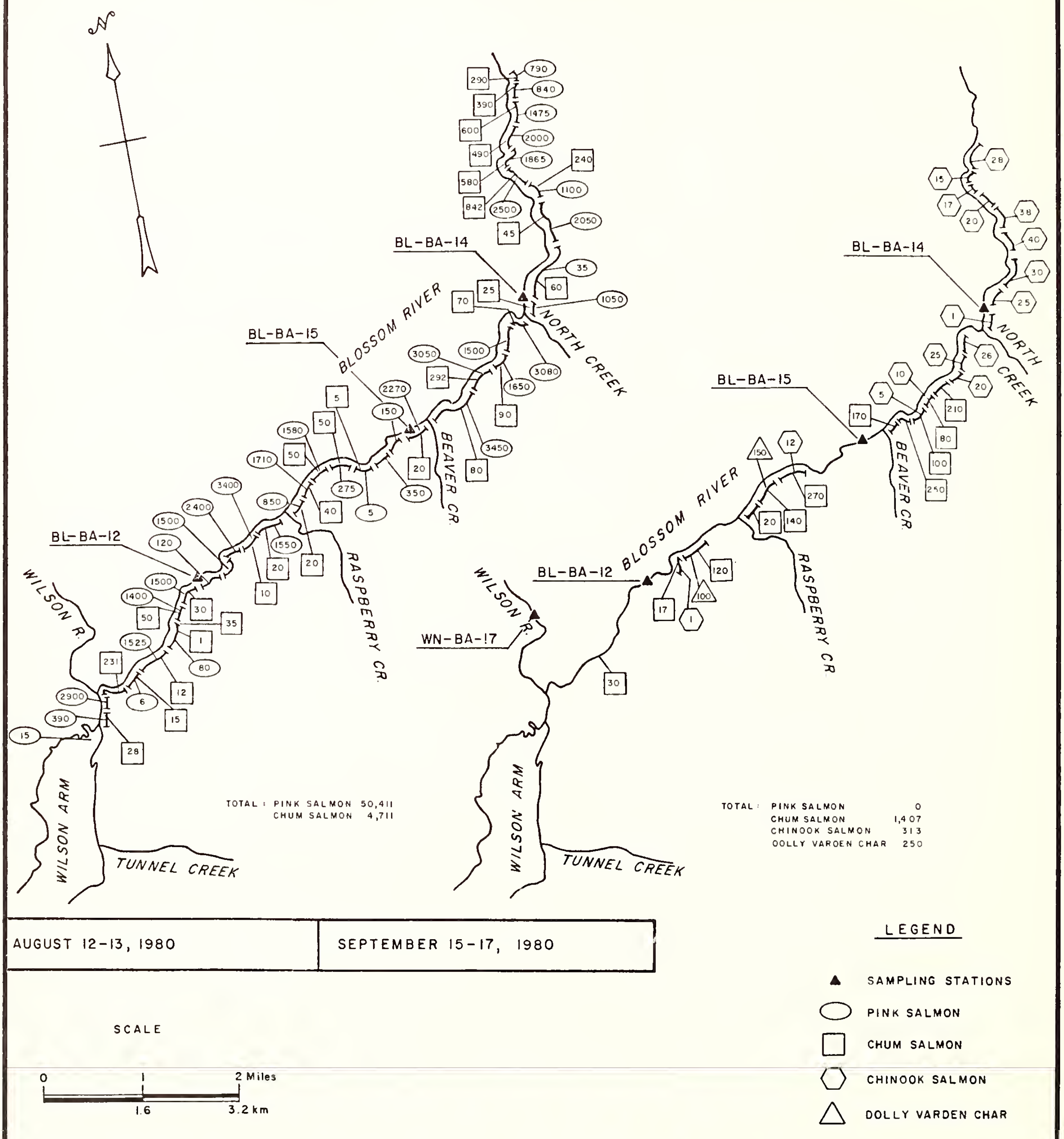
It is instructive to look at the proportion of spawning habitat that is within the potential zone of project impact for the Keta River and Blossom/ Wilson Rivers. VTN (1980b) mapped the distribution of spawning salmon on four occasions between late July and mid September 1980. Maps of the distribution of all species at the time of the peak counts for pinks and chinook are provided in Figure 3-6 for the Blossom River and Figure 3-7 for the Keta River. For the Keta River, 67 percent of pink salmon and 48 percent of chum salmon were found downstream from Hill Creek with recorded pink and chum salmon in the potential impact zone numbering 10,730. Considering the Blossom River and lower Wilson River (below the Blossom confluence) as a unit, 48 percent of pink salmon and 13 percent of chum salmon were found downstream from Beaver Creek with fish in the impact zone numbering 24,593.

Chinook and coho salmon are less abundant than pinks and chums, but nevertheless contribute to important commercial and sport fisheries. Average peak escapements for chinook salmon, for 1975-1980, are (Alaska Department of Fish & Game 1980; Francisco 1981):

	Keta River	Wilson and Blossom Rivers
Mean	255	109
Range	84-426	68-153
Years of data	6	6

On the average, peak escapements of chinook salmon are greatest in the Keta and lowest in the Wilson (ADF&G 1980; Francisco 1981). Information on coho escapements is sparse but limited data suggest an average annual escapement of 500 to 1000 fish in both the Keta and Wilson/Blossom systems (ADF&G 1980).

Other salmonid species in the Quartz Hill area are: cutthroat trout, Dolly Varden char and rainbow trout/steelhead. Trophy cutthroat trout (over

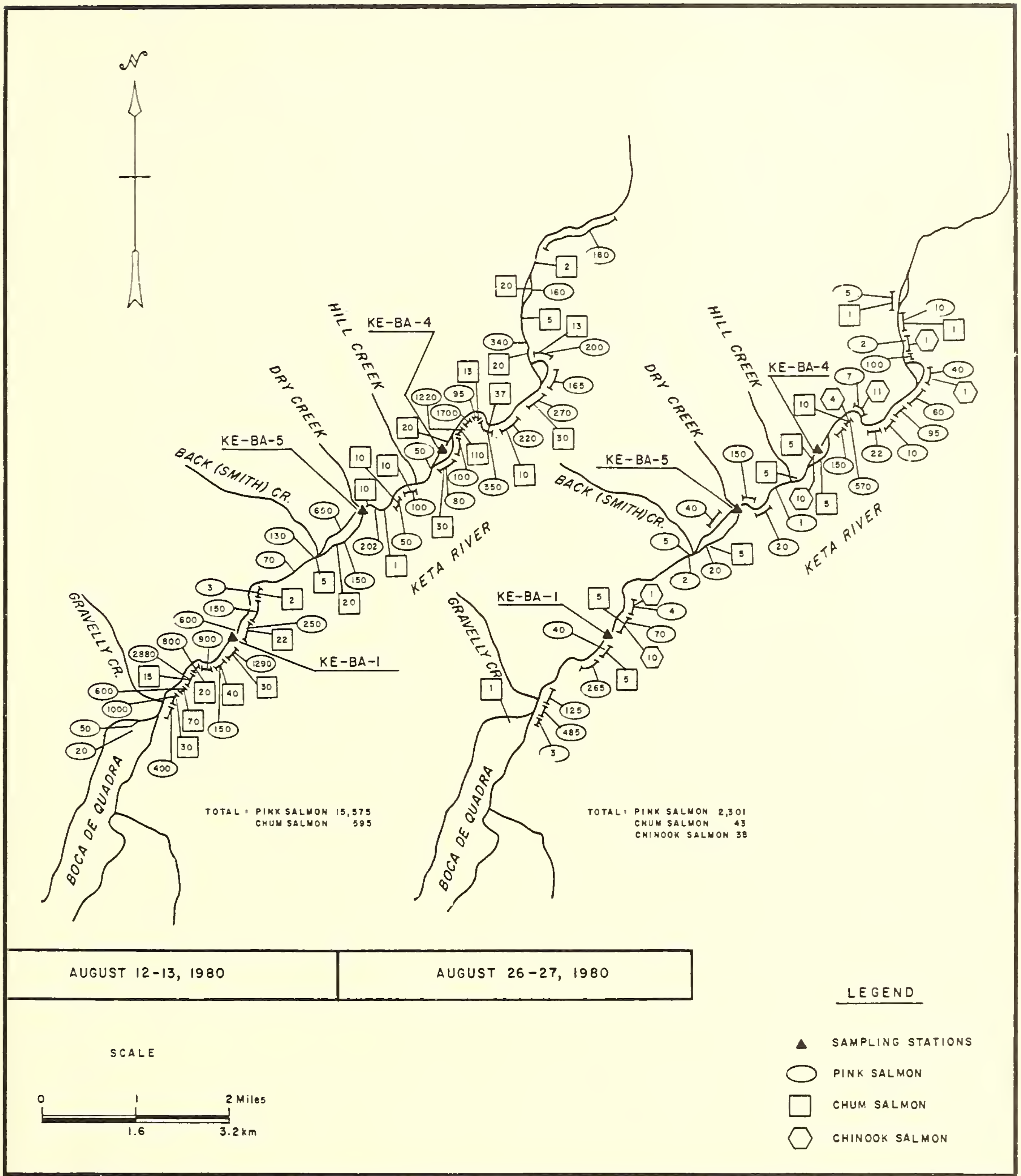


QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

OBSERVED DISTRIBUTION OF SALMON IN THE BLOSSOM RIVER AND LOWER WILSON RIVERS, 1980

Source: VTN 1980 b

Figure 3-6



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

OBSERVED DISTRIBUTION
OF SALMON
IN THE KETA RIVER, 1980

Source: VTN 1980 b

Figure 3-7

3.5 kilograms [8 pounds]) have been taken from Wilson Lake, and the Keta River supports a small sport fishery for steelhead (ADF&G 1980). The three major rivers are assumed to support both freshwater and sea-run populations of all three species (ADF&G 1980).

The distribution of all fishes found in project area streams is summarized in Tables 3-4 and 3-5. The spawning, incubation, and rearing portions of the life cycles of salmon and other salmonids are particularly sensitive periods. The timing of each stage varies with the species, as well as from year to year (Table 3-6).

Chum and pink salmon fry have been consistently captured in the main channel and major side channels of the two rivers, usually in areas where spawning adults have been observed. Juvenile chinook and coho salmon, which rear in fresh water, were found in almost all areas where there was no barrier to fish passage (VTN 1980b). Other salmonids and sculpin occur in the upper portions of some streams not supporting anadromous salmon.

Sampling data indicate that the relative abundances of juvenile salmon, Dolly Varden char and rainbow trout are approximately the same in similar freshwater habitats in the two river systems (VTN 1979, 1980b). Preliminary data indicate that, in general, the intertidal zone channels of both the Keta and Wilson estuaries support substantial numbers of juvenile salmonids. In April 1980, the catch per unit effort (primarily chum salmon) was higher in the Keta estuary than in the Wilson estuary while in June the catch for all species was higher (primarily chum, coho, and chinook salmon and Dolly Varden) in the Wilson estuary (VTN 1980b).

The streams of the Keta and Blossom drainages do not differ appreciably in the species compositions of benthic invertebrate fauna (VTN 1980b). The streams of the Keta drainage exhibited somewhat higher densities of benthic invertebrates than did the streams of the Blossom drainage. However, because the estimates of benthos density varied greatly, these differences were statistically significant at only one sampling period. Studies by Elliott

TABLE 3-4

FISH OCCURRENCE IN SELECTED BLOSSOM RIVER STREAMS/TUNNEL CREEK

	Salmon				Other Salmonids			Other Species	
	Chinook	Coho	Pink	Chum	Cutthroat	Steelhead	Dolly Varden	Sculpin	Stickleback
Blossom Tributaries:									
Beaver Cr., lower	R	R				+	R	+	
Beaver Cr., upper	<—— NO FISH CAPTURED ——>								
No. 1 Cr.	<—— NOT SAMPLED ——>								
Raspberry Cr., lower	RS*	R	S		+	R	R	+	
Raspberry Cr., upper	<—— NO FISH CAPTURED ——>								
No. 3 Cr.		R				+	R	+	
Fuel Cache Cr., lower	R	R					R	+	+
Tunnel Cr., lower	R	R	S	S			R	+	
Tunnel Cr., upper							RS	+	
Unnamed creek south of Tunnel Cr.	<—— NOT SAMPLED ——>								
Wilson side channel	R	R**	RS	RS			R	+	+

+ = Present
R = Rear
S = Spawn
* = U.S. Forest Service observation, July 1981
**= Dames & Moore observation, June 1981

Source: VTN 1979, 1980b; Francisco 1981

TABLE 3-5

FISH OCCURRENCE IN SELECTED KETA RIVER STREAMS/ARONITZ CREEK

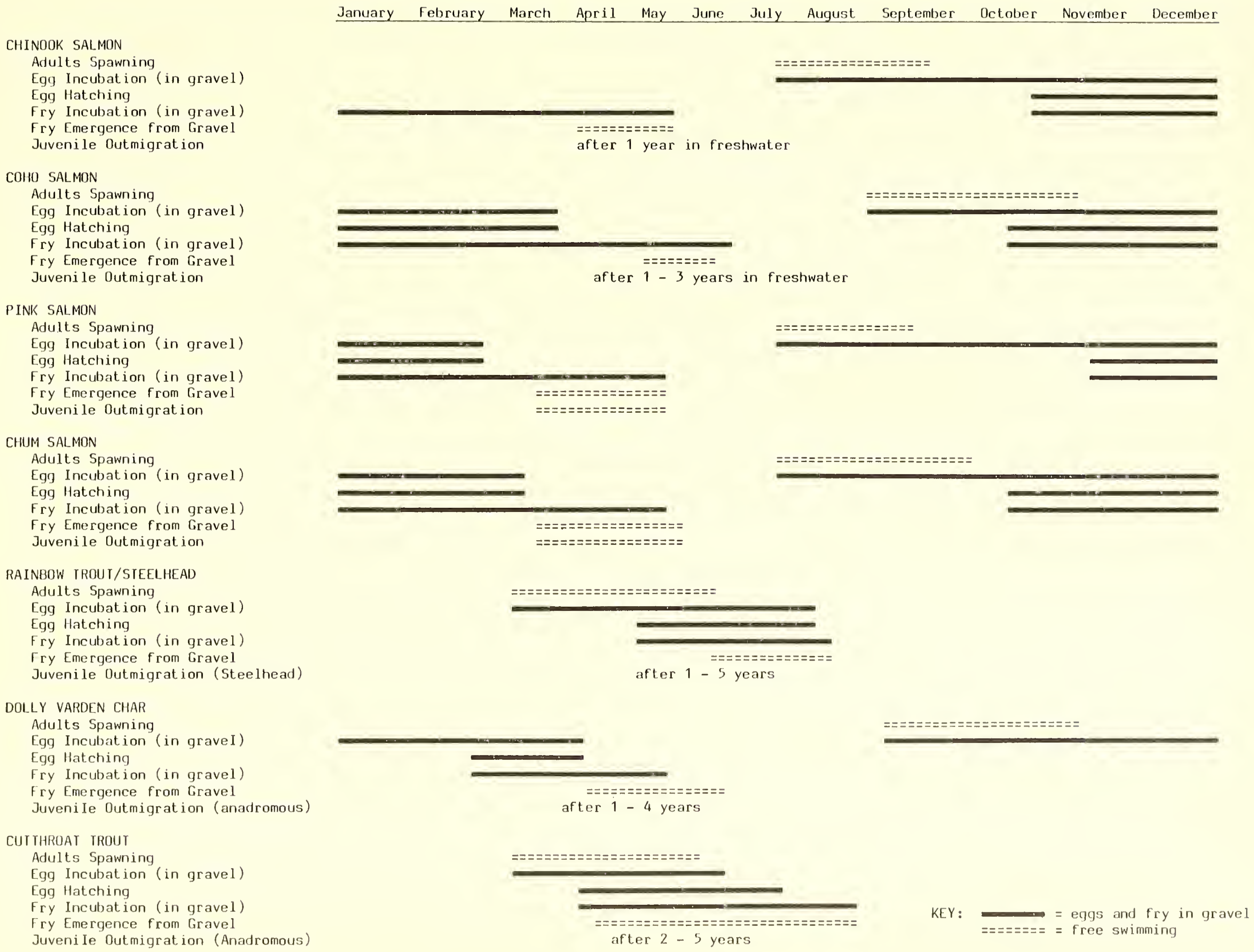
	Salmon				Other Salmonids			Other Species	
	Chinook	Coho	Pink	Chum	Cutthroat	Steelhead	Dolly Varden	Sculpin	Stickleback
Keta Tributaries:									
White Cr.	<—— NO FISH CAPTURED ——>								
Hill Cr., lower	RS	RS					R	+	
Hill Cr., middle							R		
Hill Cr., upper							R		
Notch Cr.	<—— NOT SAMPLED ——>								
Deep Cr.	<—— NOT SAMPLED ——>								
Dry Cr.	<—— NOT SAMPLED ——>								
Smith/Back Cr., lower	R	R					R		
Smith/Back Cr., upper	<—— NO FISH CAPTURED ——>								
Gravelly Cr.	<—— NOT SAMPLED ——>								
Keta River, mainstem	RS	RS	S	S	+	RS	RS	RS	
Keta River, side channels	R	RS	S	S		R	R	R	+
Keta Estuary, side channels		R*	RS	RS			R	+	+
Aronitz Cr.	R	RS	S	S		R	R	+	

+ = Present
R = Rear
S = Spawn
* = Dames & Moore observation, 1981

Source: VTN 1979, 1980b; Francisco 1981

TABLE 3-6

TIMING OF LIFE HISTORIES OF THE SALMONID FISH OF THE QUARTZ HILL AREA STREAMS



(1980) tended to confirm the above trends but again the high sample variability makes conclusions difficult. Biomass and productivity of the benthic invertebrates were not measured, and may or may not confirm these observations. Statistical analysis of periphyton (attached algae) density estimates did not indicate significant differences between the streams of the Wilson Arm or Boca de Quadra systems.

3.5 MARINE

Marine environments in the project area, Smeaton Bay (Wilson Arm) and Boca de Quadra, support a considerable diversity of marine life with a significant although not large commercial harvest potential. In addition, the marine environment is of major importance as a rearing area and migration pathway for the commercially and recreationally important salmonids that spawn in area streams. Herring and other commercial species spend portions of their life histories in the area. Oceanographic and biological aspects have been described in detail in the CAD. Only the most pertinent aspects are presented below.

3.5.1 Ecological Aspects

Phytoplankton and the rockweed *Fucus* sp. appear to be the major types of plant material produced in both Boca de Quadra and Smeaton Bay/Wilson Arm. Thus, these algae are probably a major source of energy driving the planktonic and benthic systems in these bays. Any alterations of water quality that change algal production levels would be accompanied by corresponding changes in the production of zooplanktonic and benthic assemblages because of the generally close linkages between food supply and consumer production (VTN 1978, 1979).

Zooplankton includes major consumers of phytoplankton and is a major dietary component of important fishes in these bays, e.g., juvenile salmonids and Pacific herring. Zooplankton is thus a major link between phytoplankton and higher trophic levels. It also includes larval stages for most of the important crustaceans (e.g., shrimps and crabs).

Habitats in the intertidal zone are comprised mainly of cobble/boulder or rock substrates (80 percent). Less frequently observed are mixed sand/gravel and silt/clay beaches, primarily at the heads of each fjord and bay or near large stream mouths. Proportionately, intertidal habitats are far less abundant than subtidal habitats. Rocky intertidal habitats are generally steep and narrow near the heads of Wilson Arm and Boca de Quadra and associated biotic assemblages probably contribute relatively little to the overall energy flow within the fjords. The most important contributions of the rocky intertidal habitat may be plant material and planktonic invertebrate larvae, used as food by pelagic and subtidal animals including outmigrating juvenile salmon.

Intertidal areas at the heads of Wilson Arm or Boca de Quadra would be altered by the proposed access roads and are, therefore, of particular importance. Soft intertidal substrates at the head of Boca de Quadra (Keta River delta) support somewhat impoverished infaunal assemblages (VTN 1978, 1980c). Intertidal and estuarine habitats on the Wilson delta include a higher percentage of fine-grained sediments than on the Keta delta and appear to have a substantially greater diversity and abundance of invertebrates (J. Houghton personal observation). In June 1981, abundant young-of-the-year coho salmon were present in runoff channels through the Wilson delta. These fry were somewhat less common in Keta delta channels surveyed (J. Houghton personal observation). The soft intertidal and shallow subtidal habitats in both fjords are thus important to outmigrating juvenile salmonids as feeding areas and to coho salmon fry as summer nursery areas.

Most recent data indicate that species diversity is generally higher in the subtidal zone than on comparable intertidal habitat (VTN 1980c). Contribution of algal material from rocky habitat in deeper waters is probably minimal to the overall energy budget of the fjords compared to planktonic productivity. However, some components of the subtidal benthos are highly dependent on shallow water attached algal productivity.

3.5.2 Commercial Fisheries and Potential Nursery Areas

Most of the species of potential commercial importance in these bays live on or near the bottom on soft substrates. Major epifaunal species on soft substrates in Boca de Quadra and Smeaton Bay include shrimps and Dungeness and tanner crabs (VTN 1978, 1980c, 1981). Major demersal fishes include eelpouts, flathead, English and yellowfin sole, and walleye pollock. Diversity of epifaunal species and demersal fish was higher in Boca de Quadra. In both Boca de Quadra and Smeaton Bay, epifaunal species with highest biomass in trap surveys were Dungeness crab, tanner crab, and spot shrimp. Catch per unit effort (CPUE) was substantially higher for Dungeness and tanner crab in Smeaton Bay, but for pink and spot shrimp in Boca de Quadra.

Estuaries at the head of each fjord are of considerable importance to the early marine growth and survival of salmonids emigrating from their natal streams. Pink and chum salmon smolts have been well documented as dependent on small benthic and epibenthic crustaceans for their marine feeding, while coho, chinook, and sockeye salmon smolts tend to feed near the surface in more open waters (e.g., Simenstad et al. 1980). The duration of residency of salmonid juveniles in these fjords and the extent of feeding along the steep, rocky shoreline are under investigation but not yet reported. The contribution of fish produced in tributaries of each of the fjords to commercial and sport fisheries is not well documented.

The extent to which these fjords serve as nursery areas for other species harvested elsewhere is not fully known. Information obtained from sport fishermen (but not yet substantiated by scientific field survey) indicate that halibut, black cod (sablefish), ling cod, pollock, rockfish, and hake use Smeaton Bay and Boca de Quadra as rearing and feeding areas (ADF&G 1980). There is little commercial effort for these species in the area. Exploratory commercial fishing efforts by a chartered commercial fisherman indicate that stocks within either fjord are too small to support a bottomfish fishery under present harvesting and marketing conditions. However, stocks from several areas could collectively support a fishery.

Both Smeaton Bay and Boca de Quadra have resident stocks of herring (ADF&G 1980). Heavy herring spawning near the mouth of Boca de Quadra, at Kah Shakes, and Bullhead Cove supports a sac-roe fishery. Both Smeaton Bay and Boca de Quadra appear to be important nursery and rearing areas for juvenile herring, some of which would be expected to contribute to the sac-roe fishery.

Historically, Boca de Quadra and Smeaton Bay have supported a limited commercial shellfish harvest (Table 3-7) primarily by one vessel working out of Ketchikan. Due to the more protected access to Smeaton Bay from Ketchikan, Alaska Department of Fish & Game (1980) assumed there is a higher unreported sport and subsistence shellfish usage of this system compared to that in Boca de Quadra. The statistical area that includes Boca de Quadra is considerably larger than the statistical area that includes Smeaton Bay (ADF&G 1980).

3.6 NATIONAL MONUMENT STATUS AND WILDERNESS VALUES

ANILCA designates most of the Misty Fjords National Monument as wilderness in accordance with subsection 3(c), of the Wilderness Act (78 Stat. 892). Within the Monument a 61,760-hectare (152,610-acre) tract (Figure 1-1) was withheld from wilderness designation for the purpose of providing sufficient area for the development of the Quartz Hill molybdenum deposit. The Act further provides that wilderness designated by this Act shall be administered in accordance with applicable provisions of the Wilderness Act (Sec. 707, ANILCA). The wilderness exclusion area while not classified as wilderness remains in an essentially wilderness state except for existing mine exploration activities.

There are distinct values associated with the wilderness classification that can be impacted to varying degrees depending upon the choice of development location. It is desirable to plan such development with full consideration of the impacts on wilderness values.

So as to better provide an understanding of wilderness values, several terms are described below:

TABLE 3-7

SHELLFISH HARVEST FROM BOCA DE QUADRA (STATISTICAL AREA 101-30) AND SMEATON BAY (STATISTICAL AREA 101-55), 1969-1978

	Dungeness Crab		Shrimp	
Year	Boca de Quadra	Smeaton Bay	Boca de Quadra	Smeaton Bay
	(pounds)			
1969	0	0	0	1,280
1970	324	0	4,054	0
1971	2,059	0	815	2,190
1972	2,164	0	1,190	165
1973	4,523	0	0	0
1974	1,765	1,020	0	808
1975	5,315	1,036	0	0
1976	0	0	538	465
1977	4,951	2,615	0	25
1978	--	--	0	0
Average	2,345	519	660	493

Source: ADF&G 1980.

1. Wilderness (Wilderness Act, Sect. 2[c]) - An area where the earth and it's community of life are untrammeled by man, where man himself is a visitor who does not remain.

2. Wilderness (Wilderness Act, Sect. 2[c]) - An area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements of human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation....

3. Wilderness Administration (Wilderness Act, Sect. 2[a]) - Wilderness shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character....

4. Wilderness Use (Wilderness Act, Sect. 4[b]) - Except as otherwise provided in the Wilderness Act, wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use.

5. Wilderness Use (Forest Service Manual 2320.1) - The presence of large numbers of people in any wilderness area even though they may cause little or no damage to the soil, vegetation, water or wildlife, erode and may eventually remove the wilderness resource from the land.

   The wilderness resource is dominant in all management decisions where a choice must be made between wilderness values and visitor or any other activities.

6. Forest Service Wilderness Management Objectives (Forest Service Manual 2320.2)
    a. Maintaining an enduring system of high quality wilderness.
    b. Perpetuate the wilderness resource.
    c. Provide, to the extent consistent with items a and b, opportunities for public use, enjoyment, and understanding of wilderness, and the unique experiences dependent upon a wilderness setting.

Activities associated with existing valid mining claims are permitted within the Monument, subject to certain limitations within the Act, and to:

> "Reasonable regulations promulgated by the Secretary to assure that such activities are compatible to the maximum extent feasible, with the purposes for which the Monument was established."

ANILCA states the intent to preserve wilderness resource values and related recreational opportunities including but not limited to hiking, canoeing, fishing, and sport hunting. The Act also allows airplane and motor boat uses, which are the only reasonable means of access.

3.7 HUMAN ENVIRONMENT

The human environment that would be affected by the access road and bulk sampling activities is comprised of two separate geographic areas -- the project area itself within the Misty Fjords National Monument, and the Ketchikan vicinity, which represents the nearest major existing U.S. settlement. Although the town of Kitsault, British Columbia is closer to the site, the major logistics and personnel support base will be Ketchikan. The project area is uninhabited except for mine exploration crews, and consideration of the human environment is therefore limited to those aspects of human concern: wilderness, recreational, and aesthetic experiences associated with the project area, and cultural resources. In Ketchikan and the Ketchikan Gateway Borough, socioeconomic factors will also be affected.

3.7.1 Socioeconomic Aspects

The nearest major existing U.S. community to the proposed mining operation is the City of Ketchikan, which is located approximately 72 kilometers (45 miles) to the west of Quartz Hill. The 1980 population of the Ketchikan Gateway Borough (including the city) is estimated at 12,600 by the borough. Population growth over the past decade has been slow and steady, with a 7 percent increase between 1979 and 1980. Approximately two-thirds of the total borough population resided within the City of Ketchikan in 1980. This is primarily due to the fact that Ketchikan has historically been the focus of almost all cultural, administrative, and commercial activities and for many years was the only place to have public electricity and water. Federal land ownership of adjacent lands has also limited residential expansion.

The 1970 census listed a total of 3,006 housing units of all types for the borough. By 1979, an additional 1,274 units (comprised of 538 single-family units, 557 multi-family units, and 197 mobile home/trailer units) raised this total to 4,280. Vacancy rates are very low, according to statistics compiled by the borough.

Although most of the land within and around the borough falls under Federal jurisdiction, selection and conveyance to the State, borough, and Cape Fox Village Corporation has been proceeding under the Alaska Statehood Act and the Alaska Native Claims Settlement Act. This will dramatically increase land availability in the 1980s. The borough's land program involves selection of over 4,692 hectares (11,593 acres) and is scheduled for its first sale by late 1981 or early 1982 (Ketchikan Gateway Borough 1981).

The Ketchikan Gateway Borough School District had a 1980 enrollment of 2,485 students (Ketchikan Gateway Borough undated). School enrollment has declined by 10 percent since 1970. This is consistent with similar declines nationally.

Travel and shipment of freight to and from the island community of Ketchikan rely exclusively on air and water transportation. Road systems are limited to the developed portion of Revillagigedo Island (48 kilometers [30 miles] of state highway) and to temporary roads used for timber harvesting (about 16 kilometers [10 miles]). Ketchikan is also a gateway community for the Alaska State ferry system.

The primary generators of income in the region are timber oriented (lumber and pulp). Income in large amounts is also funneled into the region through Federal, State, and local government and construction. The distributive industries that are generated by these activities employ more people than the primary industries themselves. Since 1969, only the Federal government and commodity-induced industries have failed to grow significantly. All other sectors, notably distributive industries, logging, and State and local government, have grown substantially (Charles Pool & Associates 1980).

The shares of local employment and wage payments accounted for by each major industrial sector of Ketchikan's economy are presented in Table 3-8.

Commercial fishing also represents a significant aspect of Ketchikan's economy. The results of a household survey conducted early in 1980 by the Borough Planning Department, modified by results presented in Alaska Fisheries Labor Statistics published by the Alaska Department of Labor, indicated 593 persons engaged in commercial fishing on a full- or part-time basis; or the equivalent of 262 full-time commercial fishing jobs, about 5.2 percent of Ketchikan's resident work force. Estimated annual income for fishermen ranges from $13,000 to $19,500, depending on assumptions regarding percentage of vessel ownership (Charles Pool & Associates 1980).

Tourism is also an important part of Ketchikan's economy. Combined expenditures of in-state and out-of-state visitors totaled about $15.3 million in 1979 (Charles Pool & Associates 1980).

TABLE 3-8

KETCHIKAN INDUSTRIES: EMPLOYMENT AND WAGES, 1979

Industry	Total Employment (percent)	Total Wage Payments (percent)	Average Annual Wage
Manufacturing	19.6	28.0	$28,300
Retail	15.3	8.6	11,000
Services	14.5	9.9	13,400
Local Government	13.8	13.9	--
Transportation, Communications, and Utilities	11.1	10.5	18,800
State Government	8.3	11.1	26,500
Construction	5.3	7.6	28,000
Federal Government	5.0	4.8	--
Finance, Insurance, and Real Estate	4.0	3.2	15,700
Wholesale	2.4	2.7	22,000
Total Employment and Wage Payments	5,317	$105,149,000	$19,800

Source: Statistical Quarterly, Alaska Department of Labor in Charles Pool & Associates (1980).

3.7.2 Aesthetics

Most peak and ridge summits in the project area are generally rounded as is evidenced by the distinctly smooth, rounded ridge lines between the Blossom and Keta drainages. Major landscape features of this area are the long narrow fjords that penetrate this land mass. The Smeaton Bay - Wilson Arm fjord and Boca de Quadra are in fact the longest in the Monument. Short, narrower arms branch off these major bays often creating interesting spatial qualities. All these bays are surrounded by steep, heavily forested slopes up to an elevation of about 600 meters (2,000 feet), above which are found scattered scrub timber and some high muskegs. Above this zone are alpine vegetation and rock on the ridges and peaks. The forest cover becomes more uniform toward the mouth of these bays and along the Behm Canal where elevations are generally no higher than 762 meters (2,500 feet).

The major rivers flowing into these bays are also prominent landscape features. The Keta River flows in a relatively direct course into Boca de Quadra. Its valley and the upper half of the bay form one long narrow space. Draining into Wilson Arm from different directions are the Wilson and Blossom Rivers, which meet just above the head of the tide flats. The convergence of these major valleys and the presence of prominent side drainages create a more complex spatial quality than is found in Boca de Quadra. Because of this, the bends in the arm itself and the greater size and complexity of the tide flat, there is somewhat greater overall landscape diversity at the head of Wilson Arm than in Boca de Quadra.

Based on methods described in the USDA handbook, National Forest Landscape Management, Vol. 2, most of the project area would rate a landscape variety Class B since the diversity of landscape elements is common to the coast range character type. By contrast the more scenic Walker Cove-Rudyerd Bay area would rate a Class A. All areas officially classified as wilderness rate a sensitivity level I; therefore, the entire land area and all waterbodies within the Misty Fjords National Monument wilderness would be considered the designated level I use area. In the case of the U.S. Borax exclusion area, the level I use areas or travel routes are confined to the significant saltwater bodies and lakes, important air routes and all trails. Smeaton Bay, Wilson Arm, Bakewell and Boca de Quadra would be the prime saltwater use areas. These use areas extend a short distance up the Wilson, Blossom and Keta Rivers (Appendix D).

Very little alteration of the natural landscapes in this region is now evident. Based on the variety and sensitivity ratings, visual quality objectives would be the retention of natural landscape character and avoidance of major alterations.

3.7.3 Noise

Currently, the high level of helicopter and fixed wing aircraft traffic between the U.S. Borax mine site and tidewater and between tidewater and Ketchikan comprises the most noticeable human activity and the major noise source in the area. These activities are generally confined to the exclusion area. Scenic flights and tour boats visiting the area also contribute to noise levels and are distributed over a wider area.

3.7.4 Recreational Use

The Misty Fjords wilderness designation is new and comprehensive management planning has not yet been accomplished. Therefore, several assumptions have to be made regarding past, present, and future recreation use patterns.

Accurate use figures for the wilderness area have not been collected but will be obtained in the near future for preparation of a wilderness management plan and also the final mine development environmental analysis. The current use is estimated by the management personnel through observation while working the area and contact with the visitor industry providing access and use services. Commercial use by cruise ships, private charters and flight-seeing by air taxi services has evolved from almost nothing three years ago to a daily occurrence through the tourism season. Hunting and sport fishing use by local residents will continue in proportion to local population size. The majority of users (estimated to be 90 percent) visit the Granite Fjords area with emphasis on the Walker Cove - Rudyerd Bay area. There is nothing to indicate that this area will not continue to be the prime area of human activity in the wilderness area. The two Forest Service cabins on Wilson Lake and one on Bakewell Lake represent use areas of particular significance in relation to the Quartz Hill development.

The Boca de Quadra fjord, because of the solitude possible, currently contains high quality wilderness values. The scenery is not unlike that of many other inlets and fjords in southeast Alaska. Because of access difficulty and the lack of outstanding scenery, human use historically has been low based upon observation. Pending more formal planning it is assumed that this traditional use trend will persist.

Waterways serve as primary access within the Monument. Most of the recreational activity on land occurs directly along the beaches. Much of the magnificent scenery within the Monument is viewed from the water.

3.7.5 Cultural Resources

The proposed project area was the subject of a recent cultural resources investigation conducted by Ackerman and Gallison (1981), Arctic Research Section, Laboratory of Anthropology, Washington State University, in August 1980. The survey area encompassed the upper section of Smeaton Bay and Boca de Quadra, and the mountainous interior between those two inlets. The survey area was divided into two general zones; a high mountain (elevation 150 to 300 meters [500 to 1,000 feet] above sea level and higher) and interior valley zone; and a river estuary and coastal zone. Twenty-one specific sites were investigated within the two zones. Conclusions reached by the investigators were that the landscape in the interior zone was not conducive to prehistoric or historic settlements and that no cultural values would be impacted in the development of the mineral resources within the zone.

The river estuary and coastal zone included the Wilson-Blossom River and Tunnel Creek estuary at the head of Wilson Arm, the Falsegate estuary of Bakewell Arm, and the Keta River and Aronitz Creek estuary in Boca de Quadra. Historic use within this zone included hand logging and seasonal fishing camps between the 1900s to 1940s. No evidence was found of prehistoric use, but it was concluded that some sites could fall into the historic to late prehistoric category. The investigators also concluded that while none of the sites investigated would currently qualify under criteria for nomination to the National Register, five were judged to fall in a "potentially nominatable" category. These included two cabin ruins sites at the head of Wilson Arm; an oval depression and rock pile that could have some prehistoric significance at the head of Bakewell Arm; an historic site containing pilings, cabin ruins, and evidence of hand logging at the mouth of Bartholomew Creek; and a site at the mouth of Aronitz Creek that produced no cultural evidence but does have sufficient ethnographic data to justify further exploration (Ackerman and Gallison 1981).

The site (No. 19) at the mouth of Aronitz Creek would be the only significant site in close proximity to the proposed Keta access road. Also, only one significant site area (No's. 5 and 6) was found that is in the vicinity of the proposed Blossom River access road. This area, located at the southeast corner of the Wilson estuary was suggested for future exploration based on ethnographic data.

It should be noted that the archaeological survey was of short duration (1 week) and was restricted to surface examination of sites. Test excavations were not made. Additionally, a Forest Service archaeologist has written several papers on possible aboriginal occupation within the Misty Fjords National Monument area (Campbell 1980, 1981).

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 NO ACTION ALTERNATIVE

The no action alternative would mean that no road would be built by U.S. Borax, that future exploration activity by U.S. Borax would probably cease, and that existing exploration equipment and facilities owned by U.S. Borax would probably be removed from the project area.

4.1.1 Social and Economic Effects

The alternative of not conducting the proposed bulk sampling activities would have both local and national/international socioeconomic impacts. If the access road is not approved then no bulk sampling would occur.

Direct local impacts would be relatively minor and would include the loss of approximately 100 new jobs for the 1- to 2-year construction period, a portion of which would be filled by local workers; loss of the potential income to Ketchikan businesses related to services and supplies such as air charter services, groceries, and other supplies for the Quartz Hill operation; and loss of income related to transportation and entertainment services that would be sought by off-shift workers in Ketchikan. On the other hand, social service problems related to off-shift workers in Ketchikan would not occur.

Indirectly, failure to conduct the access road construction and bulk sampling activities could result in a decision by U.S. Borax not to pursue mine development, which would result in approximately 860 permanent jobs not being realized over the 70-year economic life span of the mine. This point was discussed in the concepts analysis document (CAD) and will be addressed in more detail in the EIS for the total project.

The most significant impacts of the no action alternative relate to the national and international effects of failure to pursue mine development.

As noted in the CAD, benefits of mine development include providing a substantial contribution to the expansion of the mineral extraction industry in the State of Alaska; providing further economic diversity in southeast Alaska, thus reducing dependence on the lumber and fishing industries; increasing the U.S. production of molybdenum and assuring a more steady domestic supply of an essential mineral resource; increasing the geographic diversity of molybdenum production, thus protecting against stoppages in supply due to natural disasters, mine shutdowns, or other reasons; and contributing to a more favorable balance of payments through sales of molybdenum to other nations.

Possible regional impacts that would not occur under the no action alternative include the stimulation of the regional economy and attraction of more people to southeast Alaska, which would change the current small-town character of Ketchikan and the wilderness character of the Misty Fjords region; and possible adverse effects on the commercial fishing industry of the area.

4.1.2 Effects on the Physical and Biological Environment

If the access road and bulk sampling phase and future mine development phases were prohibited from proceeding, exploration activities at Quartz Hill could cease and U.S. Borax would be required to rehabilitate existing disturbed areas. None of the impacts to the physical and biological environment described in the remaining sections of this chapter would occur and the area would essentially regain its wilderness character. Some development scars would remain in the ore body vicinity for an indefinite time period but would become less conspicuous with the passage of time.

Not developing the Quartz Hill molybdenum deposit could create a future need for molybdenum mines at other locations. The extent of this need would depend on worldwide conditions of supply and demand. If substitute mines were developed, environmental impacts of unknown, but significant, magnitude would occur at some other location(s). Whether or not the impacts would be greater than or less than those that would occur at Quartz Hill cannot be determined.

4.2 BULK SAMPLING WITH SURFACE ACCESS VIA THE BLOSSOM RIVER VALLEY

4.2.1 Effects on the Physical Environment

4.2.1.1 Air Quality

Construction of the marine facilities and access road, extraction of the bulk sample, and other activities would entail atmospheric emissions from heavy construction equipment, from tugs or other marine vessels, and from power generation for the construction camp and drilling equipment. All of these sources are likely to be from diesel engines. Because they are individually low volume sources and because they would be temporily and spatially dispersed, they would result only in temporary and localized degradation of the existing excellent air quality in the region.

Fugitive dust from exposed earth surfaces, especially those receiving heavy equipment traffic, may create local air quality degradation that would be of limited duration (due to the generally high levels of rainfall in the region) and of negligable biological significance. During periods when lack of rainfall creates conditions for dust generation, areas would be watered to reduce or eliminate the problem.

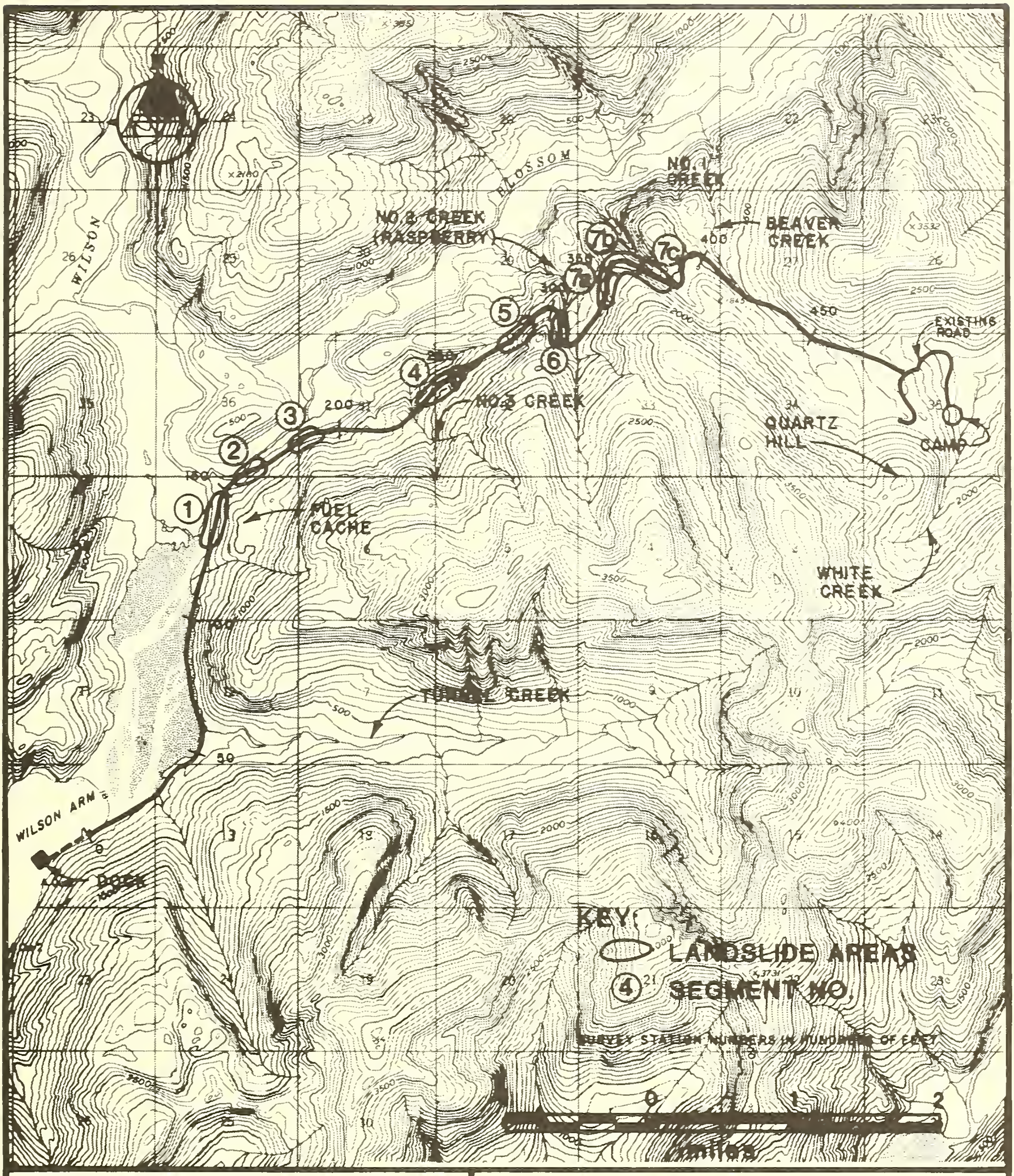
4.2.1.2 Soil and Slope Stability

Substantial portions of the Blossom access route traverse very steep to precipitous cross slopes. In some places the slopes are composed of essentially bare rock. However, in most areas there is a generally thin soil cover (probably about 0.3 to 0.9 meters [1 to 3 feet]) over the rock. In most cases the soils are composed of highly organic sandy silt or silty sand with rock fragments. This soil material is rather unstable and it is likely that construction activities would lead to the development of shallow landslides of the soil over the rock in many areas. This would result from the disturbance of the soil at the margins of the roadway excavation from material lost over the side of the hill from the alignment. Slides would also be caused by blasting shock. This situation can be mitigated by careful attention to the excavation operations but probably cannot be prevented entirely. The most critical segments of the alignment with respect to slide issues are those having slopes greater than 68 percent (Swanston 1970). Approximately 26 percent or about 3.8 kilometers (2.4 miles) of the alignment would have slopes exceeding 68 percent.

In many places, any such slides would disturb or destroy the hillside forest vegetation and alter local drainage patterns to a degree. These effects could extend up to 760 meters (2,500 feet) from the alignment, and could cause detrimental impacts to the Blossom River or its tributary creeks. Figure 4-1 shows the areas of unstable soils where landslides would be possible. Along the Blossom route there are seven sections that have been identified through soil analysis and engineering mass movement analysis to have the potential of experiencing some degree of construction-induced landsliding. Table 4-1 gives an estimate of the amount of material that could be produced from each section and the likelihood of this material entering a water drainage system. There is no practical way to prevent slide debris from affecting these streams over the short term. Revegetation and other soil and slope stabilization methods would alleviate long-term transport of soil material.

It should be remembered that slides of similar and larger scale occur naturally in this region from time to time usually associated with high precipitation in spring and fall. Typically, high flows in the creeks remove the debris and restore stream channels and water quality in the streams to their preslide condition within a year. (The major slides that took place on the east side of the Hill Creek valley in 1978 are examples.) See Section 4.2.1.4 for a discussion of water quality impacts. The vast majority of slides would occur during or within the first year following construction. However, a limited amount of delayed sliding could prolong effects in some areas.

The road construction would result in the excavation and wasting of the soil within the roadway prism and excavation and placement of the fill (as well as some wastage) of rock material. The new adit entrances and



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

AREAS HAVING HIGH LANDSLIDE POTENTIAL ALONG THE BLOSSOM RIVER ACCESS ROUTE

Figure 4-1

TABLE 4-1

SEGMENTS OF THE BLOSSOM RIVER ACCESS ROUTE THAT ARE SUSCEPTIBLE TO CONSTRUCTION-INDUCED LANDSLIDES

Segment No.	Slide Area (acres)		Volume (cu. ft.)		Quantity of Material Likely to Reach Minor Streams (cu. ft.)		Quantity of Material Likely to Reach The Blossom River (cu. ft.)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	0.4	0	40,000	0	--	--	2,000	0
2	4.8	4.8	420,000	420,000	--	--	--	--
3	12.6	12.6	1,100,000	1,100,000	--	--	--	--
4	41.3	20.6	3,600,000	1,800,000	1,800,000	900,000	360,000	45,000
5	2.7	2.7	240,000	240,000	48,000	48,000	48,000	48,000
6	5.5	5.5	480,000	480,000	480,000	480,000	480,000	480,000
7a	10.3	4.1	900,000	360,000	--	--	--	--
7b	6.9	0.7	600,000	60,000	--	--	--	--
7c	2.7	2.7	240,000	240,000	240,000	240,000	240,000	240,000
TOTAL	87.2	53.7	7,620,000	4,700,000	2,328,000	1,668,000	1,130,000	813,000
TOTAL (cu. yds)			28,200	174,100	86,200	61,800	41,850	30,100

pads would require stripping soil and excavating rock for an area of 30 meters (100 feet) wide to 60 meters (200 feet) long. Because of the slope, both cutting and filling would be required to develop the pads.

4.2.1.3 Hydrology

Stream crossings are not expected to change the hydrologic characteristics along the Blossom route. However, inadequate engineering design and/or poor construction techniques could create problems with scour or ponding. Ponding, if it was a significant volume, would moderate the peaks and valleys of the hydrograph below the stream crossing. Scour is unlikely to create significant problems because most streams are in deep valleys and cannot develop new channels. Exceptions along the Blossom route include the unnamed creek in the Fuel Cache area, the two channels of Tunnel Creek, and the unnamed creek closest to the marine facilities site. These creeks have two or more channels at the point of crossing, which is just below the point where the gradient decreases upon entering the Wilson floodplain. Proper engineering and construction of the crossings of these streams would mitigate potential adverse hydrologic effects.

The roadway and any resulting slide material would alter the drainage patterns of water flowing on the surface or in the shallow soil layer. Water flowing over the bare rock in areas of mass failure along steep terrain would be intercepted by the slide pile at the toe of the slope. Initially, water would flow over and through the waste pile as sheet flow. Channelization through the waste pile would eventually occur if the volume of water was large enough. The potential for channelled flow to extend from a waste pile to an existing stream depends upon distance, gradient, soil type, vegetation, and the elevation of the groundwater table. Although the probability for landslides along much of the side hill segment of the Blossom route is high, the probability of channelization reaching the Blossom River may be low because: (1) the distance between the route and the Blossom River is relatively long, (2) the gradient between the toe of the slopes and the river is flat along much of the area, and, (3) vegetation is dense and acts to reduce water velocity. However, there will be channelization in some areas that are close to tributaries (see Figure 4-1). A stream impact modelling study that is in progress will consider the probability of channelization and the effectiveness of intervening terrain in preventing channelled flow. Results will be available for the final EIS.

Roadway cuts typically intercept groundwater flows and convert the flow to overland flow. This flow would be directed into the roadway drainage system, and the types and magnitude of potential impacts would be directly related to the adequacy of the drainage system. Such flows begin, reach a peak, and recede within a short period and are likely to occur only during large rain storms and snowmelt.

The lack of construction in the floodplain of the Blossom River and the relatively large amount of buffer between the river and the route indicate that the potential for adverse hydrologic impacts on the Blossom River drainage is less than for the Keta route.

4.2.1.4 Water Quality

Because of the central importance of the water quality issue as related to impacts on fish resources, two different approaches have been used in considering water quality impacts. This section discusses impacts qualitatively with impact assessment based on professional judgement. The stream impact modelling study to be completed for the final EIS will provide a quantification of impacts resulting from sediment transport and deposition.

Construction of the marine facilities in Wilson Arm would result in a short-term increase in sediment and turbidity in the water adjacent to the construction activity. Nutrients may exhibit a temporary increase in concentrations. Other water quality characteristics are not expected to display any significant changes due to construction activity.

Water quality also would be impacted by road construction. The major impact would result from an increase in sediments and turbidity, and minor impacts may result from increasing nutrient levels, decreasing dissolved oxygen levels, and decreasing pH. Potential impacts that could be significant to biological resources are directly or indirectly related to sedimentation caused by surface erosion, mass soil movement, and channel erosion. Of these, the most common and significant water quality impacts would result from construction-caused mass soil movement and chronic erosion from road surfaces and cut slopes.

Traverse crossings of small streams would result in immediate, but short-term, sedimentation from disturbances within and near the streams. The potential for sedimentation is reduced because no channel changes or relocations are planned and there should be little or no channel erosion. Most stream channels are stable and the streambed material consists of sand, gravel, cobbles, and boulders. Consequently, work in the wetted perimeter of the streams would not cause an excessive amount of sedimentation.

Landslides would be the source of most sediment. The probability of mass soil movement is high along the side hill segment of the Blossom route (Table 4-1). In some areas, it is unlikely that mass soil movements would greatly affect the water quality of the Blossom River because of the extent of the buffer zone between the river and the route (see Section 4.2.1.3 Hydrology). Channelization could develop between slide waste piles along the toe of the slopes and the Blossom River; however, the existing buffer zone would act as a sediment trap if it exceeds 30 meters (100 feet) in width. The analysis presented in Table 4-1 takes into account the buffering capacity of intervening terrain. Results of the stream impact modelling study, to be presented in the final EIS will amplify this discussion.

Mass soil movements reaching the small tributary streams would dramatically increase the suspended solids concentrations and turbidity values, may increase nutrient levels, and may change pH values within these streams and the Blossom/lower Wilson Rivers. Dissolved oxygen levels may be depressed slightly, but the levels would return to normal within a short distance downstream because of the roughness and gradient of the streambeds. Surface erosion would also occur during and immediately after road construction and then decline to about pre-construction levels within a relatively short time. The potential for long-term impacts from surface erosion is directly related to the adequacy of the drainage system and the time required to stabilize slopes through reseeding of slide areas and cut banks. The extent of sediment transport from construction areas to streams would depend heavily on the amount of precipitation occurring during the construction period.

Based on existing water quality data and the soil movement analysis in Table 4-1, it is estimated that the annual sediment load within the Blossom and lower Wilson Rivers would be increased by about 400 percent during the year following initiation of road construction:

Natural Sediment Load	6,500 tons/yr.
Construction-Induced Load	
Landslides	18,300 tons/yr.
Sheet Erosion	1,050 tons/yr.
Total	25,850 tons/yr.

Some of this sediment would be carried through the river system and deposited in Wilson Arm while a substantial portion would be deposited throughout the length of the river below the points of sediment input. The stream impact modelling study in progress will help to define the amounts and locations of deposited material. The greatest amount of deposition would occur during low flow periods and in low velocity stream reaches. Most deposited material would be washed from the stream bottom during subsequent high flow periods.

An exhaustive long-term study by Cederholm et al. (1981) on an area of similar topography and rainfall (Washington's Olympic Peninsula) provides an instructive example. These investigators examined sediment production from different sources related to the construction and use of gravel surfaced logging roads. Table 4-2 presents some of their data. It should be noted that landslides and road surface erosion were the primary sources. Road surface erosion became drastically reduced under light road use as compared to heavy use.

Estimates of potential sediment input are rough and actual amounts could vary substantially from those presented in Table 4-1. Nevertheless, it appears that short-term increases in suspended sediment concentrations would be significant within the Blossom and lower Wilson Rivers. It is expected that the majority of sediment transport would occur during the year following construction with decreasing amounts thereafter.

TABLE 4-2

AVERAGE SEDIMENT PRODUCTION FROM ROAD-RELATED SOURCES

Source	Total Production (tons/road-km-yr)		Production of Fines (<2 mm) (tons/road-km-yr)	
	Christmas	Stequahelo	Christmas	Stequaleho
Landslides				
Initial failure	46	77	13	19
Secondary erosion	3.0	6.0	3.0	6.0
Rills	.9	1.7	.9	1.7
Gullies	.4	.8	.1	.2
Sidecast erosion	.7	1.0	.7	1.0
Debris flows	4.5	16	1.3	4.0
Backcut erosion	1.6	1.6	1.6	1.6
Road surface erosion and backcut erosion				
Heavy use	500		500	
Temporary non-use	67		67	
Moderate use	41		41	
Light use	3.8		3.8	
Paved	2.1		2.1	
Non-used	.5		.5	

Source: Cederholm et al. 1981

Activities occurring at or near Quartz Hill in relation to mineral exploration could affect water quality in a number of ways. Groundwater draining from the adits would contain both suspended sediments and different chemical characteristics than surface waters and would enter the Keta River drainage via White Creek. Water treatment including the addition of floculating reagents, settlement in the silt box, and additional detention time in the settling pond would remove most suspended materials. Water discharge would be on vegetated terrain via a perforated pipe and thus would be dispersed over a large area. Although adit drainage water contains substantially higher mineral concentrations than does surface water in White Creek (U.S. Forest Service 1981b), dilution by the much higher flows in White Creek and ultimately the Keta River would prevent a significant alteration in water quality except in the vicinity of the discharge. U.S. Forest Service water quality monitoring programs for existing Quartz Hill exploratory activities confirm this conclusion.

Surface drainage from waste rock at the adit pads and especially the waste rock storage area at Bear Meadow Adit No. 1 could also affect surface water quality. Waste rock leachates would be expected to have higher than normal concentrations of minerals and suspended solids, similar to the adit drainage water. The analysis conducted in the CAD suggested that leachate from Quartz Hill waste rock would not be acidic because of low sulfide concentrations and high buffering (acid neutralization) capacity. This condition would tend to prevent toxic heavy metals from dissolving in the water and toxic concentrations of mineral constituents would not be anticipated. Drainage from the adit pads and waste piles would be collected and treated with the adit discharge to remove suspended material. No significant impact on White Creek or the Keta River drainage would be anticipated from waste rock drainage.

Runoff from the various roadways proposed for the Quartz Hill vicinity would contribute to suspended sediment problems similar to those described for the access road. However, surface drainage from the existing Quartz Hill roadways has not caused noticeable water quality alteration in White Creek or the Keta River. The new roadways would not be expected to cause any greater effects.

4.2.2 Effects on the Biological Environment

4.2.2.1 Wildlife and Terrestrial Habitats

Surface areas of the various habitat types directly altered by the proposed access road, marine facilities and ore sampling facilities are expressed in Table 4-3. Habitat types used in Table 4-3 are modified from the vegetation types and subtypes proposed by VTN (1980d). Approximately 14.3 hectares (35.7 acres) would be lost to biological production during the life of the roadway and for an indefinite period thereafter. An additional 26.7 hectares (66.2 acres) within the road right-of-way would be disturbed by clearing; productivity of cleared areas would probably be reduced from that of undisturbed terrain. It is expected that on steep terrain road construction would cause debris (primarily soil, rocks, and vegetation) to slide downslope. This would create additional areas of reduced plant productivity similar to natural landslides. Approximately 30 percent of the Blossom route is on terrain susceptible to such sliding (slopes greater than 68 percent). From 22 to 35 hectares (54 to 87 acres) of terrain could be altered by slides based on Table 4-1. Additional direct disturbance to the estuarine marsh would probably occur as a result of unloading barged construction equipment at the upper intertidal area for road construction. Detailed plans have not been developed; therefore, impacts cannot be accurately determined.

The road passes through five major habitat zones: mature coastal forest adjacent to Wilson Arm, estuarine marsh at the edge of the intertidal area, poorly-drained forest on the Blossom valley side, forest edge bordering muskeg and alpine meadow in the Beaver Creek valley, and muskeg and open forest near Quartz Hill.

The most important wildlife habitat area disturbed by the road would be the segment of estuarine marsh (up to some 2.5 hectares [6.2 acres]) along the Wilson delta. The value of this area is probably enhanced by its position immediately adjacent to the forest edge and its association with intertidal aquatic habitats. Most of the long middle segment of the road traverses a forested side slope that does not appear to support unusual

TABLE 4-3

QUANTITIES OF TERRESTRIAL HABITAT ALTERED BY THE BLOSSOM RIVER ACCESS ROAD, MARINE FACILITIES, AND MINERAL EXPLORATION FACILITIES

			Surface Area (hectares [acres])		
	Habitat Type	Linear Distance (m [ft])	Filled or Cut Area(1)	Additional Cleared(2)	Total
ACCESS ROAD	Mature coastal spruce/hemlock forest-adjacent to Wilson Arm	2,490 (8,180)	2.0 (4.9)	3.8 (9.4)	5.8 (14.3)
	Side-slope forest-Predominately poorly-drained hemlock/cedar with some well-drained spruce/hemlock and small patches of muskeg	8,412 (27,600)	6.6 (16.5)	12.8 (31.7)	19.4 (48.2)
	Forest edge-Mostly poorly-drained forest bordering muskeg and alpine meadow in Beaver Creek Valley	2,286 (7,500)	1.8 (4.5)	3.5 (8.6)	5.3 (13.1)
	Wetland				
	Estuarine marsh	1,100 (3,600)	0.8 (2.1)	1.6 (4.1)	2.5 (6.2)
	Muskeg	914 (3,000)	0.7 (1.8)	1.4 (3.4)	2.1 (5.2
MARINE FACILITIES	Mature coastal spruce/hemlock forest-adjacent to Wilson Arm		1.0 (2.5)	0.4 (1.0)	1.4 (3.5)
MINERAL EXPLORATION FACILITIES	Wetland				
	Mixed non-forested and forested muskeg		2.4 (5.9)	3.6 (9.0)	6.0 (14.9)
	TOTAL WETLANDS		3.9 (9.8)	6.6 (16.5)	10.5 (26.3)
	TOTAL		14.3 (35.7)	26.7 (66.2)	41.0 (101.9)

(1) Based on a corridor 7.9 meters (26 feet) wide for the access road (4.2-meter [14-foot] driving surface, 0.9 meters [3 feet] of fill and 2:1 embankment slope). Actual width of undistrubed areas would vary depending on depth of fill and/or height of cut slope.

(2) Based on 7.6-meter (25-foot) clearing width of both sides of roadway or pad.

levels of wildlife use. Habitats traversed by the portion of the road parallelling Beaver Creek would probably be considered to have moderate value because of proximity to more heavily used muskeg and meadow areas.

In view of the undisturbed nature of the surrounding terrain, it is unlikely that direct habitat withdrawal alone would impact regional wildlife population levels significantly. Some local displacement of animal species would occur.

Impacts resulting from noise and activity would probably be substantially greater at least in the short term than those resulting from direct habitat alteration because of the much larger impact zone. During construction of the road and marine facilities, activity and noise level would be intense and would occur 24 hours per day. Blasting would be required for the marshalling yard on Wilson Arm and along a major portion of the roadway. The most extensive blasting for the access road would be associated with the steepest terrain, particularly the middle segment of the road east and west of Raspberry Creek. Most mobile animals, particularly birds and larger mammals, would abandon or avoid areas of high disturbance.

Waterfowl associated with the estuarine marsh at the head of Wilson Arm would probably be particularly vulnerable to disturbance. Construction would overlap with spring migration, nesting, and fall migration periods. Waterfowl use and nesting success on the southeast margin of the marsh would probably decrease during 1982. Since the marsh is 0.8 kilometer (1/2 mile) or more wide, birds could find some refuge on the northwest side. Blasting could discourage some sensitive species from using any portion of the marsh, although no blasting would occur immediately adjacent to the marsh. Limiting blasting near the marsh to non-sensitive time periods would alleviate impacts substantially.

Four bald eagle nests are located in close proximity to (within 60 meters [200 feet]) the proposed road along the east side of the Wilson estuary (Figure 3-3). Of these nests, only the one closest to the proposed marshalling area was active in 1980 (VTN 1980d). Observations suggest the presence of eagles again in 1981, although no young were produced (Meehan 1981). Construction activity occurring during the time that the nest is being established (March 1-April 30) would be likely to prevent the birds from breeding. Activity occurring after the eggs are laid would be less likely to cause abandonment. Since the roadway would be within the 100-meter (330-foot) eagle nest buffer zone (see Section 2.3.3.4), construction activities would be prohibited during the nest establishment period and, if the nest(s) are active, during the period April 30 - August 31. This would help to mitigate impacts on eagles. Road traffic would probably not be prohibited during sensitive periods in the years following construction; therefore, chronic disturbance to nesting bald eagles would be likely during the period that the road is in operation. Permanent nest abandonment could occur. In late summer and fall, eagles concentrate in the Wilson River delta area presumably to feed on spawning salmon. Disturbance during this time could alter feeding patterns.

The reaction of brown and black bears to construction disturbance varies according to individual animals. While some animals might abandon construction areas, the trans-Alaska pipeline experience suggests that the net effect would probably be attraction of bears to construction areas because of the availability of food (Milke 1977). It would be likely that some bears would become a problem and would have to be killed. Others could become dependent on artificial food sources, resulting in a reduced ability to survive. Proper disposal of wastes and prevention of animal feeding by workers would minimize this problem.

Mountain goats appear to be relatively susceptible to disturbance impacts (Singer 1975). However, goats would be unlikely to be concentrated near construction areas during the summer construction season. Goats inhabiting higher altitude terrain would probably not be seriously affected because of distance from construction areas (Figure 3-2).

The roadway both during and after construction would be likely to alter animal movement patterns. Bears and wolves would use the road as a movement corridor during times of minimal road use. Cut slope portions of the road occupying up to 50 percent of the Blossom route could block movements perpendicular to the road. Much of the Blossom route traverses the side of the Blossom River valley and would, therefore, interfere with movements from higher elevations to the valley bottom or vice versa. Male mountain goats are known to move long distances during the rut, sometimes crossing from one ridge to another via the intervening valley (Smith 1981). Goats also travel downslope into forested terrain in response to heavy snowfall and other factors. In the absence of human activity, goat movements probably would not be significantly affected by the Blossom road. However, if vehicles are present or other activities are in progress, goat movements could be hampered significantly (Singer 1975).

Perhaps the most serious impact to game animals such as goats and bears would result from the increased hunter access to high altitude areas. Hunting would be concentrated in the vicinity of the roadway and adjacent goat and bear populations would probably decrease (Pendergast and Bindernagel 1977). Controlled access or other regulations could mitigate these impacts.

4.2.2.2 Wetlands

Of the total area directly altered by the Blossom River access road, marine facilities and ore sampling facilities, 10.5 hectares (26.3 acres) or 26 percent is classified as wetlands according to the criteria presented in Section 3.3.5. In addition to direct impacts, wetland structure and function would be altered by blockage of natural drainage patterns and disturbance of wetland inhabitants. General wetland related impacts on vegetation and wildlife are presented in Section 4.2.2.1. The following paragraphs address wetland impacts in relation to the special values presented in Section 3.3.5.

Some plant and animal productivity would be lost. Muskeg type wetlands are not especially productive and are widely dispersed throughout the area. Therefore, impacts resulting from loss of productivity would probably not be significant for this habitat type. Somewhat less than 2 percent of the surface area of the more valuable estuarine meadow at the Wilson River mouth would be altered and animal use of the southeast margin of the estuary would be reduced, especially while the roadway is in use. These impacts could noticeably affect local productivity but probably would not be significant on a regional basis. Food webs would not be greatly interrupted. The possible alteration of juvenile salmon rearing habitat within the wetlands is discussed in Sections 4.2.2.3 and 4.2.2.4.

Wetland habitat available for wildlife use within the estuarine marsh and possibly along the muskeg/forest edge in the Beaver Creek valley would be slightly reduced. Waterfowl use of the southeast margin of the Wilson delta would probably be affected during construction and periods of heavy road use.

Significant impacts on local hydrological regimes and nutrient chemistry would not be anticipated from the relatively small wetland encroachments proposed for the access road and other facilities. Cross drainage provisions along roadways would minimize such effects.

The access road and marine facilities would not be expected to adversely effect recreational opportunities on the Wilson River delta over the long term. Access to potential hunting areas would be improved. The quality of such recreational experiences could, however, be reduced by the presence of man-made structures and possibly by the presence of noise and other disturbance factors.

4.2.2.3 Fish and Aquatic Habitats

ANILCA (Section 503[h][4][A]) states:

> ". . . the Secretary shall complete any administrative review of a decision on the proposal covered by the EIS and shall issue to the applicant a special use permit for a surface access road for bulk sampling unless he shall determine that construction or use of such a road would cause an unreasonable risk of significant irreparable damage to the habitats of viable populations of fish management indicator species and the continued productivity of such habitats."

Therefore, fish resources have been singled out for special emphasis in this EIS. "Fish management indicator species" would most logically include the four species of Pacific salmon present in the Quartz Hill drainages. These species are both ecologically dominant and economically important. The discussion in this section and in Section 4.3.2.3, which addresses the Keta River access, concentrates on salmon; however, most conclusions can be extrapolated to resident species because of similar habitat requirements.

The construction, operation and maintenance of an access road via the Blossom River alignment could potentially cause both direct (local) and indirect (downstream) impacts to the fish and the aquatic habitats. Qualitative discussions of these impacts will be amplified in the final EIS by the results of the stream impact modelling.

The potential direct impacts at a stream crossing point are mechanical in nature; for example, scouring or ponding in the immediate area, a slide of soil or debris directly into the stream, the shock generated by blasting, or the operation of construction equipment directly in the stream.

The potential for direct impacts to fish habitats resulting from habitat alteration on the Blossom access route would be relatively minor. An access road on the Blossom River side would cross seven creeks. Of these, only Tunnel Creek is known to support fish above and below the proposed crossing point. Raspberry Creek supports fish near its mouth, but no fish were captured in samplings upstream from the road crossing point (VTN 1980b). Six of these creeks do not appear to support any life stages of anadromous salmon at any great distance upstream from their mouths. The most severe direct impact would be the alteration of a side distributary channel of the Wilson estuary on the southeast edge of the intertidal zone. Up to 550 meters (1,800 feet) of channel could be partly or completely destroyed by road fill. These channels are used by a number of salmonid species but are particularly important as rearing habitat for juvenile coho salmon (J. Houghton, Dames & Moore personal observation). The severity of the impacts would depend on the exact placement of this road segment (in the channel or alongside it) and on the design and construction techniques and timing employed. Rechannelization or other mitigation measures along side the road would diminish impacts substantially. See Section 4.2.2.4 for additional discusssion.

Another potential source of direct impact would result from blasting. Although extensive blasting would be required to construct the Blossom access road, little would occur adjacent to fish habitat. A possible exception is the segment of road immediately above the estuarine marsh where it begins its sidehill ascent. Between Stations 108+00 and 152+00 the roadway ranges from 75 meters (250 feet) to 150 meters (500 feet) away from the lower Wilson River. Blasting could affect the survival of pink or chum salmon eggs or alevins (fry within the gravel). .The severity of such effects are a direct function of the magnitude of the shock, the proximity of fish to a source of shock, and the nature of the medium through which the shock waves must travel. The severity of the effects of seismic shock is also a function of the stage of development for fish eggs and alevins. Fish eggs are most sensitive to shock from approximately 48 hours after fertilization until what is commonly termed the "eyed stage." After becoming eyed, developing eggs are quite resistant to shock. The time and duration of the most sensitive period is determined by the time of spawning and the temperature regime of the stream being considered. This time span generally corresponds to the first third of the development time from egg fertilization to fry emergence (Hayes 1949). For the Blossom and Wilson Rivers this sensitive time period would extend from mid-July until early November for pink and chum salmon. Experimental study of blasting effects is sparse. An investigation of quarry blasting 50 meters (160 feet) from a pink salmon spawning area indicated no mortality of salmon alevins (U.S. Forest Service 1964). Impact to fish would probably be unlikely unless the blasting occurred during the most sensitive stage of egg development.

The valuable fish resources of the Blossom River itself, as well as the lower Wilson River, would not sustain direct local impacts, but could be chronically or acutely affected by sediment deposition from construction of crossings of its tributaries, from runoff from road surfaces and drainage systems, and from channelization through soil and debris piles resulting from slide areas. Such effects are likely primarily downstream of No. 1 Creek.

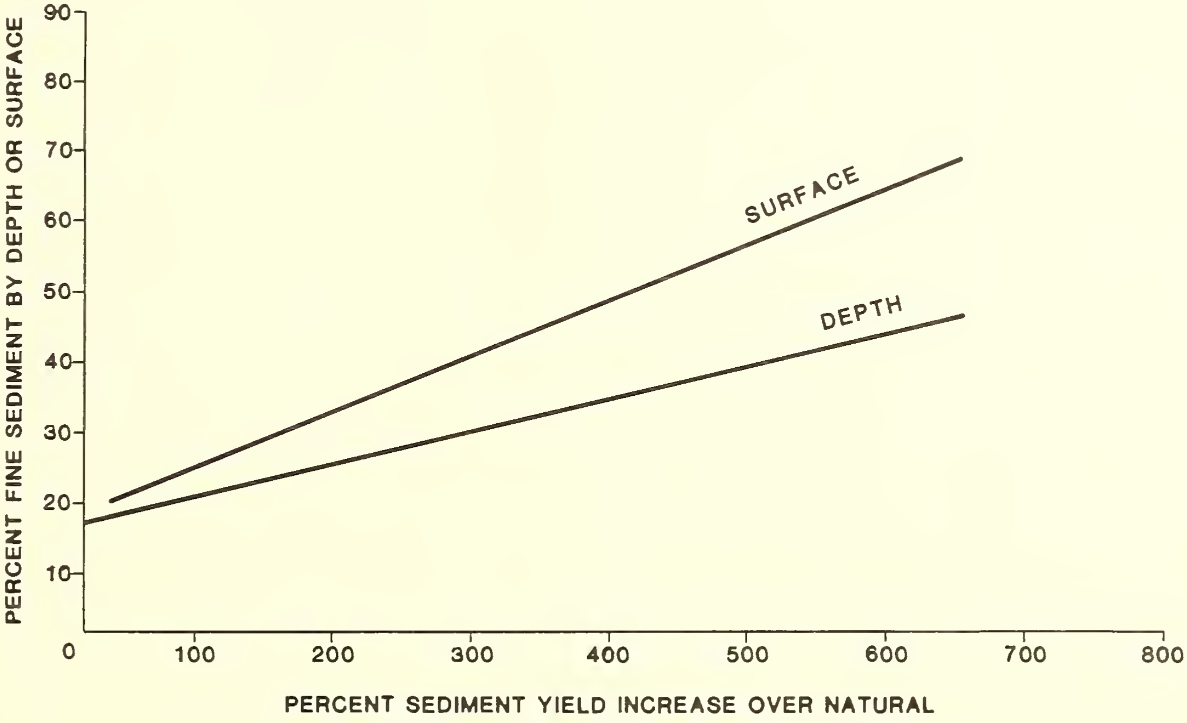
The severity of this downstream impact would depend on the quantity and depth of sediment deposited, the specific sites of deposition, and the sizes of the sediment particles. These characteristics, in turn, would depend on the stream flow at the time of sediment transport, the preconstruction quality of the substrate, the distance of a site of deposition from the source of the sediments, and the duration of sediment introduction. The stream impact modelling program currently underway will attempt to answer some of these questions.

Impacts from suspended or deposited sediments on the downstream fish and aquatic habitats may be both acute and chronic. The acute impacts would be primarily a result of increases in sediment concentrations and turbidity values in the water, which could reduce productivity by decreasing light penetration into the water and reducing algal growth. These changes could also cause increases in nutrient levels and decreases in dissolved oxygen and pH values. As concluded in the discussions of impacts to hydrology and water quality, the dissolved oxygen and pH values would return quickly to preconstruction levels within a short distance downstream. Free-swimming fish (adults and juveniles) can withstand high levels of suspended sediments. Increases in suspended sediment would be intermittant and most severe during construction. Acute impacts would probably not be severe.

Chronic downstream impacts are, potentially, the most severe and, currently, the least predictable. Impacts could result from the deposition of sediment in a tributary creek, in the Blossom River, or in the lower Wilson River. If fish eggs or larvae were in the gravel at the time of deposition, they could be suffocated by the blocking of water flow through the gravel. If the eggs or larvae were not present, the deposition of sediment could still impact fish populations by making an area of streambed unsuitable for spawning (the area would be avoided by spawning adult fish) or unsuitable for incubation (the eggs or larvae would suffocate after being deposited in the gravel). Populations of fish food organisms, especially in slow water rearing areas, could also be reduced by relatively minor accumulations of sediment. Fine sediments fill the spaces between gravel and, thus, greatly reduce the living space for small animals. Thus, increased sedimentation rates could reduce the suitability of the area for rearing of juvenile salmonids.

Impacts of sediment deposition could be either short-term or long-term. Short-term impacts would occur if sediments were deposited and then subsequently washed from the river. Long-term impacts would occur if 1) sediment transport occurred over a long time period or 2) the composition of stream substrate materials was permanently altered by fine particles becoming deeply imbedded in the stream gravels.

As described in Section 4.2.1.4, suspended sediment load would increase substantially above natural levels during and after construction. Sediment deposition would increase in the Blossom and lower Wilson Rivers. Some insight into the extent of this deposition, especially in relation to salmon spawning areas, will be provided by the stream impact modelling study now in progress. Lacking this detailed information, it may still be possible to reach some tentative conclusions regarding impacts to fish. Bjornn et al. (1980) have developed a series of composite graphs relating the percent sediment increase over natural levels to changes in various stream habitat characteristics. Figure 4-2 relates sediment yield to the percent of fine sediments both within the gravel and on the surface. Using Figure 4-2, a 400 percent increase in sediment, as suggested in Section 4.2.1.4, for the Blossom River during access road construction would increase the percentage of fine sediment in the gravels by about 17 percent over the natural condition. The percentage of fine sediment has been related to salmon egg survival by many investigators and the results are very uniform between the various sites. Figure 4-3 provides the results of some of these studies. Assuming that the natural percent fines in Blossom River spawning gravels is about 18 percent (a conservative estimate), then a 17 percent increase would reduce the percentage of salmon eggs that survive to fry emergence by 30 percent or more. All else being equal, this would result in a proportional decrease in the 1982 year-class for those salmon that spawn within the impact zone. About 48 percent of Blossom/lower Wilson pink salmon spawn in the impact zone; therefore, using the above assumptions the number of adults originating from 1982 spawners could be reduced by about 15 percent (48 percent x 30 percent). These reductions would probably be difficult to detect in marine fisheries 1 1/2 to 5 years later because of compensatory mortality in later life history stages, natural variability in marine survival factors, and lack of information on contributions of individual streams to the fishery.

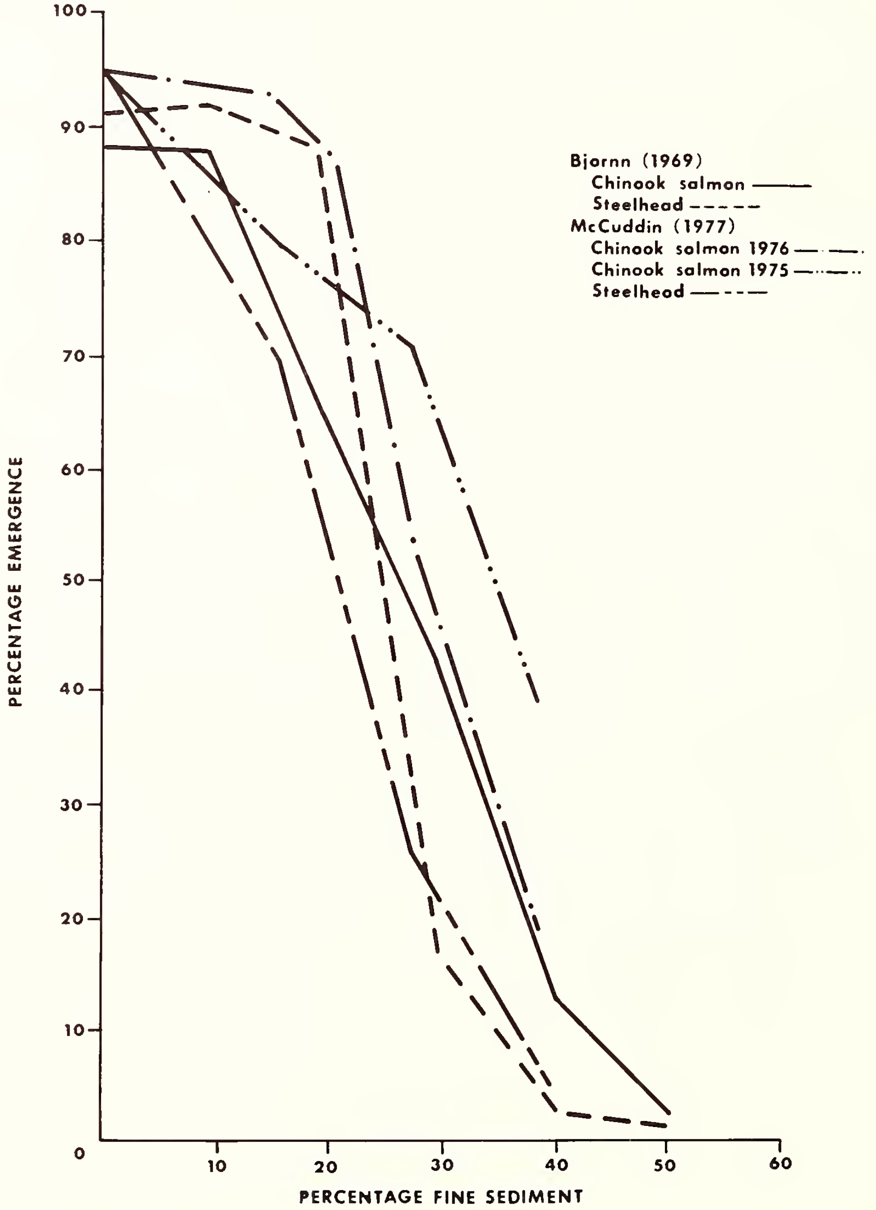


QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

PERCENT FINE SEDIMENT AS RELATED TO PERCENT SEDIMENT YIELD OVER THE NATURAL CONDITION

Source: Bjornn et al. 1980

Figure 4-2



Fine sediment was granitic sand with particles less than 6.4 mm.

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

PERCENTAGE EMERGENCE OF FRY FROM NEWLY FERTILIZED EGGS IN GRAVEL-SAND MIXTURES

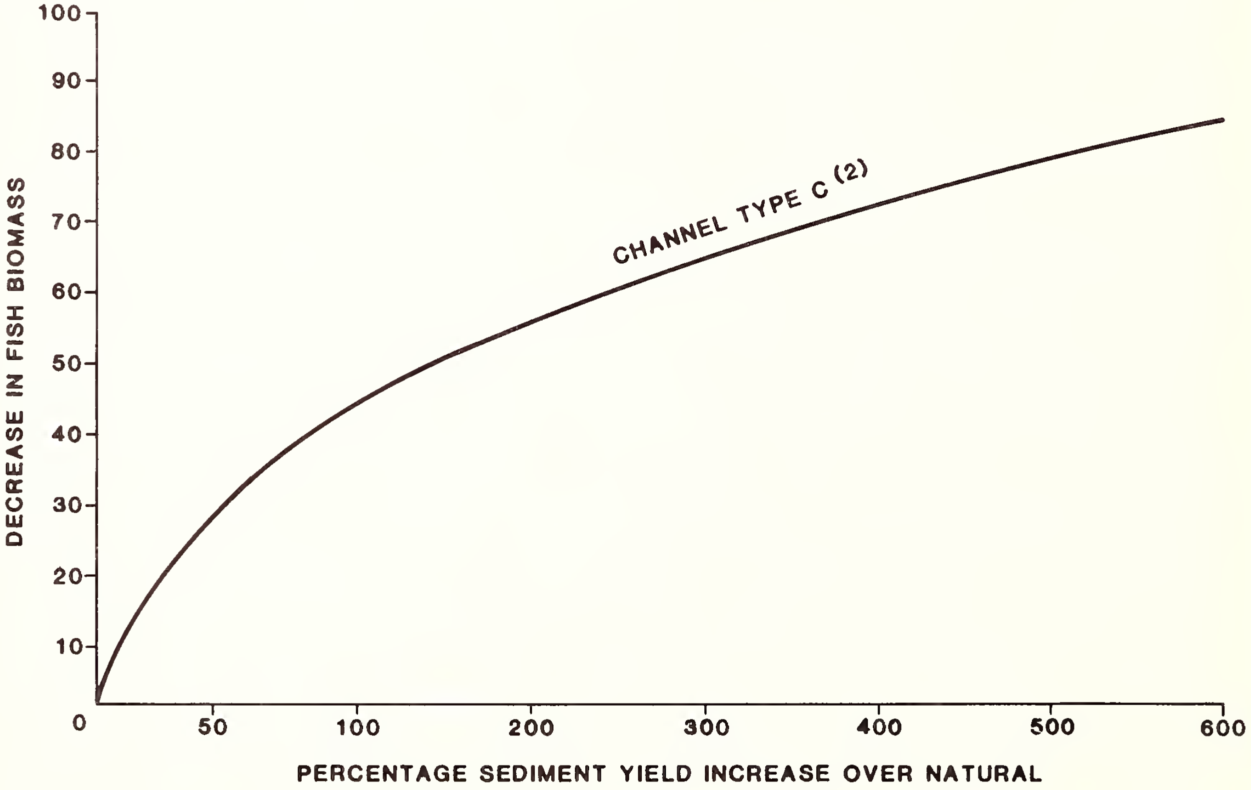
Source: Reiser and Bjornn 1979

Figure 4-3

Sedimentation has also been shown to affect the growth rate of juvenile salmonids and the carrying capacity of rearing areas (Crouse et al. 1981). Bjornn et al. (1980) examined these relationships. Figure 4-4 indicates that a 70 percent decrease in fish biomass could result from a 400 percent increase in sediment yield. It would, therefore, be probable that road construction would cause a significant decrease in growth and/or survival of young fish. Coho and chinook salmon juveniles would be vulnerable.

Most of the above impacts would probably be short-term with primary affects occurring in 1982 and early 1983. Long-term continuing deposition of sediment in the Blossom River would be unlikely unless sediment transport was extensive and prolonged. However, short-term deposition could cause long-term impacts. Relatively minor permanent differences in the percentage of fine particles in spawning gravel and in rearing areas can have subtle, but significant, effects on the survival of incubating fish eggs and on the growth of juvenile salmon. For example, increasing the amount of fine sediments (1 to 3 millimeters in diameter) in spawning substrate by 5 percent could decrease survival of salmon eggs by 30 percent or more depending on the initial percentage of fines (Figure 4-3). A reduction in egg survival for pink and chum salmon in the Blossom River would probably result in a proportionate reduction in adults available to the fishery. About 48 percent of pink salmon spawning habitat and 13 percent of chum salmon spawning habitat in the Blossom and lower Wilson Rivers would be within the zone of impact based on VTN (1980b) escapement mapping.

These subtle effects would represent the most likely potential long-term impacts to fish resources that could result from construction of the Blossom access road. However, whether or not such impacts would occur cannot be determined with certainty. The extensive literature on the impacts of logging road construction on salmon streams suggests that long-term impacts vary widely depending on circumstances. An exhaustive long-term study by Cederholm et al. (1981) on an area of similar topography and rainfall (Washington's Olympic Peninsula) provides an instructive example. They found that sediment produced from logging roads (including road-induced landslides) was accumulating in spawning gravels with an accompanying reduction in salmon



(1) THIS CURVE WAS DEVELOPED USING THE AVERAGE FROM SURFACE FINES, DEPTH FINES, EMBEDDEDNESS, AND POOL VOLUME.

(2) WIDE VALLEY BOTTOM, STREAM GRADIENT LESS THAN 4%.

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

SEDIMENT YIELD OVER THE NATURAL CONDITION AS RELATED TO FISH BIOMASS(1)

Source: Bjornn et al. 1980

Figure 4-4

egg survival. However, these effects were only noticeable in drainage basins where the road area exceeded 2.5 percent of the basin area. The proposed Blossom access road would occupy much less than one percent of the Blossom River drainage even if landslide disturbed areas are included. Sedimentation, if it occurred, would be heaviest during the summer construction period and the following winter when stream flows are low. It would be anticipated that most sediments would be washed from the system during spring and fall freshets and floods as found by Shapley and Bishop (1965).

Impacts to fish in the Keta River drainage via White and Hill Creeks could occur as a result of water quality alterations originating from the Quartz Hill facilities. Such impacts would be unlikely because of the dilution factor and distance from fish use areas. Alterations to Keta River water quality have not occurred as a result of existing exploration activities which are similar to the proposed activities.

In summary, a qualitative appraisal of the Blossom River road corridor leads to the following conclusions:

1. Most impacts to fish resulting from suspended or deposited sediments would be short-term, limited to the construction period and an indefinite time thereafter depending on the success of efforts to stabilize erodable areas. Reduction in 1982 spawning success would probably occur in the Blossom and lower Wilson Rivers as well as reduction in rearing success.

2. Sediment deposition might or might not be sufficiently severe to cause a long-term loss in the productivity of spawning areas. Long-term effects cannot be predicted on the basis of available information.

3. Little direct impact to fish habitats would occur since the road is remote from fish habitat except in the case of the small channels on the Wilson delta.

4. Temporary impact would be greater for the Blossom access when compared to the Keta access.

5. Approximately twice as many salmon spawners use the Blossom/lower Wilson impact zone than use the Keta River impact zone. Therefore, more fish would be exposed to potential impacts from the Blossom access road than from the Keta access road under worst-case conditions (all fish present subject to impact).

4.2.2.4 Marine Habitats

Marine and estuarine habitats in the upper portions of Wilson Arm would be directly affected by marine facility and road construction, as well as log transfer and rafting, and indirectly by sedimentation that might wash from road cuts or fills along the estuary or be transported to it via the Blossom and Wilson Rivers.

Marshalling area and barge ramp construction would obliterate a small area (probably less than 1,400 square meters [15,000 square feet]) of rocky intertidal and subtidal habitat and perhaps an even smaller area of soft-bottom subtidal habitat. These losses would be of no significance to local productivity. Presence of the vertical face of the barge ramp would force salmon smolts migrating along shore into somewhat deeper water, potentially increasing their exposure to predation. However, since the majority of fjord walls are very steep naturally, there should be no change in predation losses. Bark loss from log handling and rafting would add to the organic loading of sediment and could reduce oxygen levels within the sediments and at the sediment/water interface. Grounding of rafted logs during low tides if it occurred would physically disrupt benthos. However, logs would be rafted in sufficiently deep water to prevent grounding and such impacts should not occur. These impacts associated with log rafting will be short term as log rafting would occur only during one or possible two seasons. Recovery to pre-disturbance conditions should occur after 1 to 2 years.

Siltation from road and marine facility construction along the estuary could reach the marine waters at a number of locations. Quantities of sediments reaching the estuary at any one point would be small and occur only briefly. Erosion control and mitigation measures would further minimize effects. Sediment transport to the estuary via the Wilson River could increase substantially over natural background levels in the event that a major slide occurs near one of the creeks crossing the right of way on the steep slopes above the Blossom River. These sediments would settle to the bottom in areas where wave and current energies are no longer sufficient to maintain them in suspension. Since the same physical laws govern these sediments as govern naturally transported sediments, there should be little net change in grain size of surficial sediments in the estuary. However, some local smothering of benthic fauna could occur if rates of deposition greatly exceed those naturally occurring during the season in question. Such losses of benthos would be short term and of little significance to the productivity of the estuary.

The major impact of road construction on estuarine habitat would occur along the east shore of the estuary north of the Tunnel Creek mouth where steep cliffs force the road onto the upper tide flats for a distance of about 1.1 kilometer (0.7 mile). Conservatively, assuming a 15-meter (50-foot) band of disturbance in this area, some 2.5 hectares (6.2 acres) of tidelands would be destroyed, some 1.9 percent of the approximately 130 hectares (320 acres) of tideland on the delta. Major habitats affected would be the grass/herb zones above normal high water, the sedge/Fucus zone near normal high water levels and a distributary channel of the Wilson River flowing over a gravel to silt bed. Lesser areas of steeply sloped muddy sides of the distributary would be affected as well as some silty sand flats.

The grass/herb and sedge/Fucus zones are important producers of organic material that ultimately contribute to the marine productivity of the fjord. The distributary channel and associate mud banks and sand flats are important producers of epibenthic zooplankton, primarily crustaceans that are the primary food of outmigrating juvenile pink and chum salmon (e.g., Simenstad, et al. 1980). In addition, the distributary channel contained large numbers of coho salmon fry when visited in June 1981 (J. Houghton, personal observation). These fish are also dependent upon locally produced food items and may well spend a longer period of time (summer and fall?) in the area than do the pink and chum outmigrants. Access road construction may result in closure of this channel and diversion of its flow through other channels.

This would eliminate a significant portion of the small distributary channel habitat on the delta. Alternatively, the channel may be displaced to cut through what is now sedge/*Fucus* or grass/herb habitat. While this latter course of action would increase the loss of these higher ground habitats (perhaps to 2 percent of the total present), it would be far more desirable from a fisheries standpoint because it would retain the majority of the important small distributary stream habitats. It is expected that productivity of the relocated channel would be restored to near existing levels within 1 year of channel stabilization. Riprap to protect the fill would be colonized by a *Fucus* and barnacle dominated community similar to that at like tidal levels on naturally occurring hard substrates.

Limited shipping and offloading of construction equipment and material at the marine facility would have little significant impact on marine biota. Low-level releases of petroleum hydrocarbons from bilge pumping and deck or marshalling area runoff would be of little significance although low-level uptake by some benthic species might be measurable. A larger spill due to ship grounding, collision, or fuel-handling mishap would have more severe impacts, particularly if it were driven by wind or tide onto the shallow estuarine shelf at the mouth of the Wilson River during the spring. As noted above, these shallow areas are of considerable importance to the early marine survival of some juvenile salmonids, and to the rearing of others. If wave action worked the spilled oil into the soft intertidal sediments on the Wilson delta, effects could persist for several years, perhaps reducing feeding opportunities for important fish species including juvenile salmonids of both the Wilson and Blossom Rivers. Birds and mammals could suffer severe impacts. The near-vertical rocky cliffs of the littoral zone would have a moderate vulnerability to spilled oil (Gundlach et al. 1980) but would probably recover relatively rapidly. The probability of a shipping accident in transit would be low because of the limited number of vessel visits during this phase of project development. The risk and effects from spillage of a towing vessel's fuel would be similar to the risk and effects of similar spillage from a large tour vessel. However, the cargo barges may be carrying fuels that would have a considerable additional potential for ecological damage. An oil spill would also have an adverse effect aesthetically on the shoreline and particularly on small beaches. Recreation values of beaches would be diminished.

4.2.2.5 Threatened and Endangered Species

No impacts to threatened or endangered species are anticipated.

4.2.3 Effects on National Monument Management Values

The impacts from bulk sampling and construction of the access road will largely be limited to the portion of the Monument that has been identified as available, subject to conditions of ANILCA, for development of the Quartz Hill deposit. Impacts will be felt in the rest of the Monument but they will be minor compared to effects that will occur during full mine development.

4.2.3.1 Primitive Recreation Experience

The existing level of use of the Smeaton Bay/Wilson Arm area is high in relation to most of the Monument. This use is of a primitive nature due to access and the fact that relatively little impact by man has occurred on adjacent lands. Presence of the construction camp and marine facilities, road construction and associated support activities would eliminate the primitive nature of the area. While there would be some recreational use by personnel involved in the construction phase, the impacts would be minimal and short term in comparison to those of a townsite in the same area, as described in the CAD.

4.2.3.2 Ecological Values

Ecological values would be impacted to the extent that road construction and placement of facilities would impact the physical resource. Because of the steep side slopes traversed, the Blossom route has potential for up to 35 hectares (90 acres) of landslides that to some degree could affect the Blossom and lower Wilson River system.

4.2.3.3 Effects on Cultural, Historic and Prehistorical Values

Adverse effects on cultural resources as a result of access road construction and bulk sampling activities are considered to be unlikely or minimal. The archaeological survey conducted by Ackerman and Gallison (1981) found one site area that they felt warranted future investigation (Sites 5 and 6) near the Blossom River road route. The road as now designed would avoid these sites and no impact would be anticipated. The survey was of limited scope, however, and other sites may exist. It is not believed that significant cultural resources exist to the extent that road or mine development would be precluded. However, an archaeological survey employing sub-surface testing of the proposed route as recommended in the CAD should be undertaken before actual construction begins. Standard archaeological practice would be followed in the event cultural material is found.

4.2.3.4 Aesthetic Values

See Appendix D for a detailed analysis. The road along Wilson Arm and marine facilities as viewed by a traveller on saltwater would create the most significant visual impact, from the standpoint of National Monument management goals. The overall result would be a strong horizontal line introduced along the shoreline that would be more dominant than the existing line created by the natural shoreline. Because of the configuration of the upper end of Wilson Arm, the road and marine facilities would be visible from almost any position on the water as well as from the tide flat. These impacts would be inconsistent with the natural landscape and would constitute a major modification.

The roadway along the side of the Blossom River valley would be highly visible to air travellers in the Wilson or Blossom valleys. The cut slopes required on steep terrain and possible landslides would increase the visibility of the road.

Visual impacts of the Blossom River access would be greater than those of a Keta River route because: the scenic quality is higher at the head of Wilson Arm than at the head of Boca de Quadra, the different configuration of the two bays causes a larger saltwater area to be affected in Wilson Arm, and impact from the air is greater with the Blossom route because of the location of the road on the valley side and the common use of the Wilson valley as a flight corridor.

4.2.4 Effects on Wilderness and Recreation Values

The adjacent Wilderness would be somewhat affected by the access road construction. The impact would be minor compared to the impact that would be created in the future if the access road dictates mine development access. The possibility of a townsite located in the Wilson Arm area poses a significant cumulative impact to adjacent Wilderness as discussed in Section 2.3.3.8.

The most significant effect of the access road construction and the bulk sampling process would be diminishment of the quality of wilderness experience. Four recreation cabins are located within hearing distance of the operation. The noise associated with the operation would detract from the existing high quality solitude.

Air traffic associated with support activities would continue to detract from wilderness solitude.

The Smeaton/Wilson area is located adjacent to the portion of the Wilderness that traditionally has received the highest use and offers the best access to areas of high scenic beauty. Because of this, the activities in the Blossom/Wilson drainage have a higher potential for creating conflict with existing and anticipated future use than would similar activities on the Keta route.

There would be little effect on the existing low level of hunting, fishing and trapping in the area except that success of hunting in the area would be substantially reduced during the construction period.

4.2.5 Noise

Noise from blasting and heavy equipment use would disrupt large mammals and bird activities within parts of the exclusion area. Some blasting noise may be audible in designated Wilderness portions of the Monument. Increased air and boat traffic to and from the site will add to existing noise levels within parts of the Wilderness area.

4.2.6 Economic Effects

Economic effects related solely to the access road and bulk sampling activity would primarily involve the Ketchikan area. Direct local economic effects would include 80 to 100 new jobs for the 1- to 2-year construction period. The work force for road construction and bulk sampling would include truck drivers and heavy equipment operators, drillers, powdermen, foremen, time keepers, loggers, shopmen, and pilots. A portion of the work force could be filled by local workers. Income for Ketchikan businesses would also be generated, related to services and supplies such as air charter services, groceries, and other supplies for the Quartz Hill operation. There would also be economic benefits for businesses in Ketchikan providing transportation and entertainment services for off-shift workers. The actual percentage of the workers who would spend off-shift time in Ketchikan as opposed other destinations is not known, nor is the dollar amount of possible expenditures per worker. It is expected that off-shift time, and therefore economic impacts to Ketchikan businesses would be relatively small due to the brief periods of leisure time available to workers.

4.2.7 Social Effects

Social effects related directly to the access road construction and bulk sampling activities would be relatively minor, due to the small size of the work force involved, the work schedule, and the remoteness of the location. The activities involved would be similar to any other logging and road building operation of a comparable magnitude in southeast Alaska. It is expected that the majority of the work crew would be experienced in similar projects and would be prepared for the stresses of a rigorous work schedule at an isolated site. Negative impacts to Ketchikan are expected to be minor, and may involve temporary incidents such as disorderly conduct, or similar effects associated with a crew visiting from a remote site. Again, because of the small size of the work force involved, and the relatively small amount of leisure time available, these problems are expected to be negligible.

It is not expected that a significant percentage of the workers would be married and relocate their families to Ketchikan, based on experience at similar projects. However, at this point, it is not possible to more precisely identify the percentage of married and single workers, or the number of families which might relocate to Ketchikan for the 1- to 2-year duration of this phase of the project.

Welfare or unemployment problems identified as potential problems for mine development in the CAD would not present a significant problem for the bulk sampling phase.

4.2.8 Hazard Susceptibility

There is little to no potential for the bulk sampling roadway to be affected by avalanches. Studies have indicated that there are only two small intermittent snowslide or avalanche tracks along the roadway corridor (Appendix C). Neither of these are in areas where structures could be affected. There is a real possibility, however, that landslides could affect the roadway. It is expected that most shallow slides developing as a result of the construction would occur downhill from the alignment. However, it is possible that some slides could occur uphill from the alignment since the cut would remove support from the soil materials on the slope just above the cut bank. Such slides would be most likely to occur at the time of or relatively soon after construction in response to severe rain and wind storms. Their effect would be to fill or partially fill the road prism with debris, which would need to be removed to restore service.

The layout of this road upon a north/northwest aspect could create a prolonged icy road hazard. This hazard would be somewhat compounded by precipitous slopes and many road curves. Approximately 8 kilometers (5 miles) of road would be affected by icy road conditions, from station 140 to 400 (Figure 2-10). Most of the construction and subsequent transport of ore samples would occur during the thawed season. Therefore, ice would not be a serious safety hazard during the bulk sample phase unless altered schedules called for winter work.

It is conceivable that low-level temporary bridges could be affected by floods or debris flows along the creeks. The character of the channels and the nature of the drainage area above the alignment suggests that this is an unlikely occurrence, however. It is also possible that drainage could accumulate on the uphill side of embankment or cut areas, either from natural sources or from blocked culverts, and flow down and across the road leading to erosion of embankment areas. This occurrence is considered unlikely if careful attention is paid to cross drainage provisions throughout the project.

Blasting would present some hazard to human safety. Normal good construction procedures would assure the clearance of personnel from blasting areas prior to blasting. Aircraft would be notified of blasting schedules and aircraft presence would be monitored to prevent potential aircraft hazards.

4.2.9 Relationship Between Local Short-Term Use of the Environment and Maintenance and Enhancement of Long-Term Productivity

Granting a permit for the proposed short-term use for access road construction and bulk sampling would have one major impact on long-term productivity of this area: the likelihood that this action would lead to the full-scale development of the deposit via the Blossom access. Such a development would significantly increase the long-term world production of molybdenum. Full mine development would, in turn, have two primary long-term impacts on natural productivity in the area. These are: 1) destruction of substantial additional acreage of terrestrial habitat, and 2) destruction of a large portion of the existing benthic habitat in Wilson/Smeaton Bay and replacement with a tailings substrate (assuming marine disposal of tailings). This latter effect could result in long-term local reductions of numbers of some species of fish and shellfish that are harvested commercially here or elsewhere in southeast Alaska. The possible long-term impacts of mine development are discussed further in the CAD and will be addressed in greater depth in the mine development EIS.

The proposed road construction and bulk sampling would remove relatively small amounts of several local habitat types from long-term productivity. With intensive revegetation efforts, areas of disturbed soil could be restored to active production although the nature of reestablished communities would differ from the existing natural communities. Areas of steep cut rock could not be revegetated but they would eventually support growths of ferns and mosses similar to those on natural cliffs. Scars from required cuts and fills would be visible from the water and the air for many years and would detract from the existing natural scenery of the area.

Siltation effects from road construction and from construction-caused slides could affect long-term productivity of fish populations.

4.2.10 Irreversible and Irretrievable Impacts

Access road and bulk sampling would have the following irreversible and/or irretrievable impacts:

1. Loss of the existing natural character of the area due to cuts and fills for the marine marshalling area, the road, and the adit work pads as well as spoiling of unused rock excavated from the adits. This effect would be largely irreversible and irretrievable.

2. Loss of terrestrial habitat in the marshalling area, road, construction work areas and adit work areas would be partially

irreversible. Loss of productivity during a recovery period would be irretrievable.

3. Loss of up to 1.7 hectares (4.2 acres) of tideland habitat would be irreversible and irretrievable.

4. Loss of energy expended in road construction and bulk sampling would be irretrievable.

5. Loss of fish production that would occur as a result of temporary siltation of the Blossom and lower Wilson Rivers would not be irreversible; however, the opportunity to harvest these fish would be irretrievably lost.

6. Reduction in recreational, hunting, or fishing opportunities during the construction season would be an irretrievable loss.

7. Reduced reproductive success of bald eagles, waterfowl or large mammals during the construction period would be irretrievable.

4.3 BULK SAMPLING WITH SURFACE ACCESS VIA THE KETA RIVER VALLEY

4.3.1 Effects on the Physical Environment

4.3.1.1 Air Quality

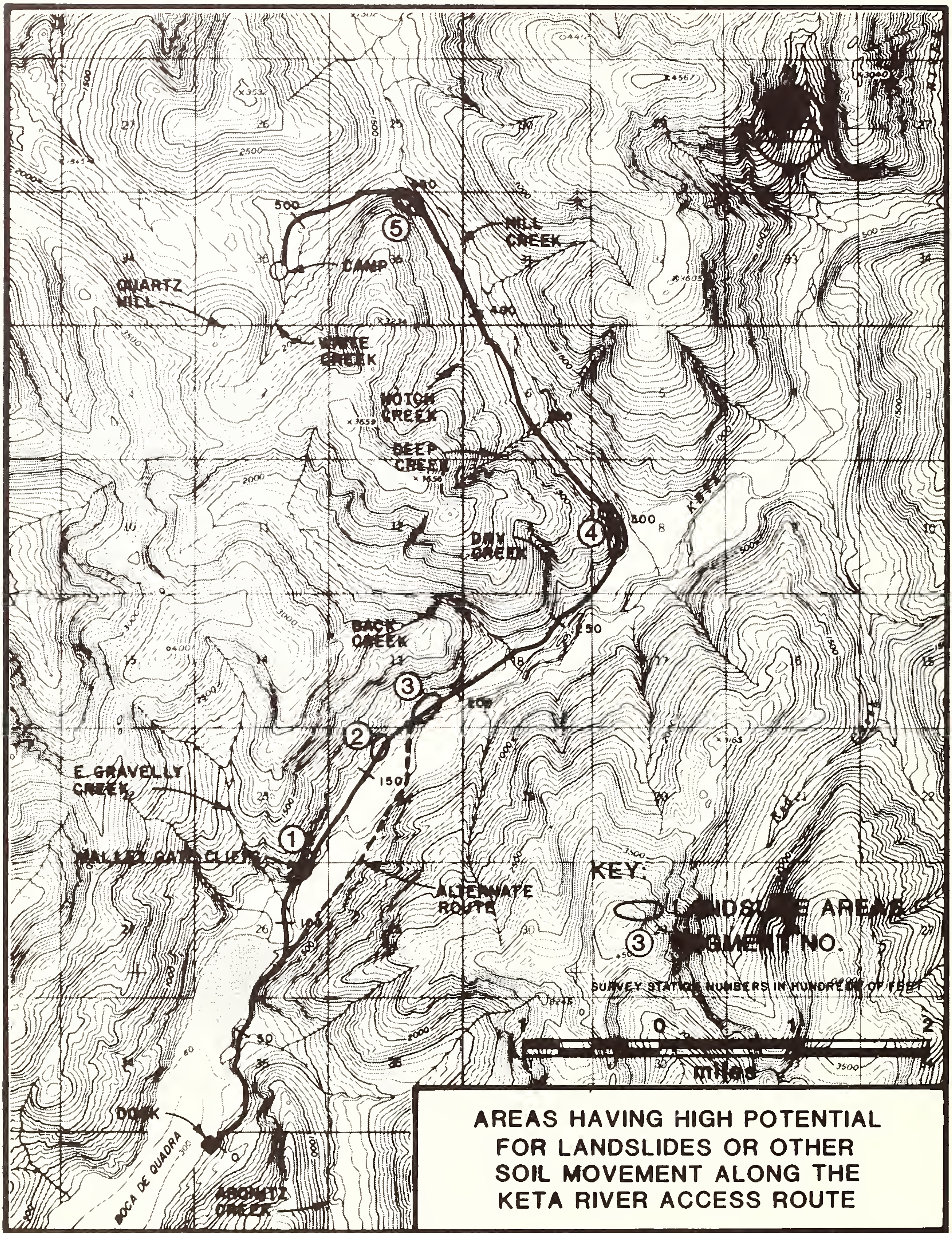
As under the Blossom access route, construction of the marine facilities and access road and extraction of the bulk sample would entail atmospheric emissions from heavy construction equipment, from tugs or other marine vessels, and from power generation for the construction camp and drilling equipment. All of these sources are likely to be from diesel engines. Because they are individually low volume sources and because they would be temporily and spatially dispersed, they would result only in temporary and localized degradation of the existing excellent air quality in the region.

Fugitive dust from exposed earth surfaces, especially those receiving heavy equipment traffic, may create local air quality degradation that would be of limited duration (due to the generally high levels of rainfall in the region) and of negligable biological significance. During periods when lack of rainfall creates conditions for dust generation, areas would be watered to reduce or eliminate the problem.

4.3.1.2 Soil and Slope Stability

Roughly 10 percent (about 1.6 kilometer [1 mile]) of the Keta access route would traverse very steep precipitous cross slopes. This is in the area where the alignment ascends from the Keta River valley to the Hill Creek valley traversing a steep rock-supported knob in the process. Additional segments of the alignment adjacent to the Boca de Quadra tidelands and in the "Valley Gate Cliffs" area also traverse very steep terrain. Figure 4-5 shows the areas of unstable soils where some construction-induced landslides or other soil movement would be possible, including fill areas within the river channel. Along the Hill Creek/Keta River route, five sections have been identified through soil analysis and engineering mass movement analysis to have the potential for experiencing some degree of landsliding or soil placement into waterways. Table 4-4 gives an estimate of the amount of material which could be produced from each section and the likelihood of this material entering a water drainage system. A comparable analysis has not been conducted for the optional Keta River road route. Segments 1 and 2 from Table 4-4 would be eliminated by the optional route but other areas could be added. The most critical segment of the alignment with respect to possible landslides is that area where the line "turns the corner" from the Keta River into the Hill Creek drainage. In that area, the steep terrain, the presence of a thin soil cover in many places, and proximity to Hill Creek would produce both the maximum potential for slides and the maximum risk of environmental damage.

Any such slides would disturb or destroy the hillside forest vegetation and alter local drainage patterns to a degree. The effects could extend to Hill Creek and in that event would dump debris or silt-laden water into



AREAS HAVING HIGH POTENTIAL
FOR LANDSLIDES OR OTHER
SOIL MOVEMENT ALONG THE
KETA RIVER ACCESS ROUTE

QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

Figure 4-5

TABLE 4-4

SEGMENTS OF THE KETA RIVER ACCESS ROUTE THAT ARE SUSCEPTIBLE TO CONSTRUCTION-INDUCED LANDSLIDES OR OTHER SOIL MOVEMENT INTO WATERWAYS

Segment No.	Slide Area (acres)		Volume (cu. ft.)		Quantity of Material Likely to Reach Minor Streams (cu.ft.)		Quantity of Material Likely to Reach The Keta River (cu. ft.)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	0.8	0.8	35,000	35,000	--	--	35,000	12,250
2	0.3	0.3	30,000	30,000	--	--	15,000	15,000
3	0.3	0.3	15,000	15,000	--	--	15,000	7,500
4	6.89	6.89	600,000	600,000	120,000	120,000	120,000	120,000
5	0.7	0	120,000	0	0	--	0	--
TOTAL	8.99	8.29	800,000	680,000	120,000	120,000	185,000	154,750
TOTAL (cu. yds)			29,600	25,200	4,450	4,450	6,850	5,730

the stream. It may be possible in a few places to partially control this problem. However, there may be no practical way to prevent the slide debris at some areas from entering Hill Creek and the Keta River.

It should be remembered that slides of similar and larger scale occur normally in this region from time to time. Typically high flows in the creeks remove the debris and restore stream channels and water quality to their preslide conditions within a year. (The major slides that occurred on the east side of the Hill Creek valley just upstream from the area under discussion are examples.)

Construction on the floodplain and tidelands would involve placing embankment fill. In some instances, this could cover or block side channels or other areas used for fish rearing. No disruption of soils is expected to occur as a result of tidelands and floodplain construction. The supporting soils are granular and stable with respect to the intended project works.

The road construction would result in the excavation and wasting of the soil within the roadway prism and excavation and placement as fill (as well as some wastage of rock material).

The new adit entrances and pads would require stripping soil and excavating rock for an area 30 meters (100 feet) wide and 60 meters (200 feet) long. Because of the slope, both cutting and filling would be required to develop the pads.

4.3.1.3 Hydrology

Direct disturbance of the Keta River and associated bodies of water by the proposed access road is an important issue because of its relation to impacts on water quality and fish resources. The following discussion emphasizes hydrological aspects but also sets the stage for subsequent discussions of impacts resulting from sedimentation and alteration of aquatic habitats.

Encroachment Analysis - An analysis of potential road encroachments on the Keta River and other wet areas was conducted with emphasis on the 5.3 kilometers (3.3 miles) of the Keta River access route that is located mostly on the Keta River floodplain. The analysis considered both encroachments into wet areas resulting in direct displacement of streams, rivers or ponds, and near to wet areas (within 30 meters [100 feet]). Between the "Valley Gate Cliffs" and the confluence of Hill Creek and the Keta River there are about 5.8 kilometers (3.6 miles) of main river channel, 3.7 kilometers (2.3 miles) of overflow channel and 20.2 hectares (50 acres) of ponds and sloughs. Table 4-5 summarizes road encroachments into or near waterbodies on the Keta River floodplain and Figure 4-6 indicates encroachment locations.

At encroachment area No. 1 (Figure 4-6) the bulk sample access road would alter the main channel of the Keta River for a distance of about 120 meters (400 feet). The road would probably exend into the river for 3 meters (10 feet), with most of this encroachment involving large rocks for protection of the road. Impacts to the road could be serious during flooding since the river would flow directly onto the road embankment. As a possible mitigation measure, the main river flow could be directed into the existing old river channel on the other side of the floodplain. Encroachment area No. 2 would alter a backwater/side channel for a distance of about 95 meters (310 feet). The width of the encroachment would depend on construction methods and amount of rock excavation but would probably be less than 3 meters (10 feet). Encroachment area No. 3 involves the same side channel. The roadway would be immediately adjacent to, but not in, the channel for a distance of about 540 meters (1,780 feet).

Encroachment area No. 4 involves the "Beaver Havens," a large area of ponded water and low velocity channels. Most of the water is supplied by side streams and some overflows of the river during peak flows. Due to the steep valley side slope, it would be necessary to place the road on the edge of this area for 730 meters (2,400 feet). Within this segment a 45-meter (150-foot) section of the road would be in an existing pond.

Table 4-5

KETA ROUTE ENCROACHMENT ON KETA RIVER AND ADJACENT WATERS - LENGTH OF ROADWAY IN OR ADJACENT TO WATERBODIES[1]

Encroachment Areas	Encroachment into Main River Channel	Encroachment Near Main River Channel	Encroachment into Side Channels	Encroachment into Other Waters	Encroachment Near Other Waters	Road Length Encroachment on All Waters
1	480 ft.					480 ft.
2			310 ft.			310 ft.
3					1,780 ft.	1,780 ft.
4				150 ft.	2,250 ft.	2,400 ft.
5		210 ft.		250 ft.	150 ft.	610 ft.
6	400 ft.			820 ft.		1,220 ft.
7				270 ft.		270 ft.
Total Road Length	880 ft.	210 ft.	310 ft.	1,490 ft.	4,180 ft.	7,070 ft.
Percent of Total Road Length	5.5	1.3	1.9	9.3	26.1	44.1
Percent of Total Length of River	4.6	1.1				

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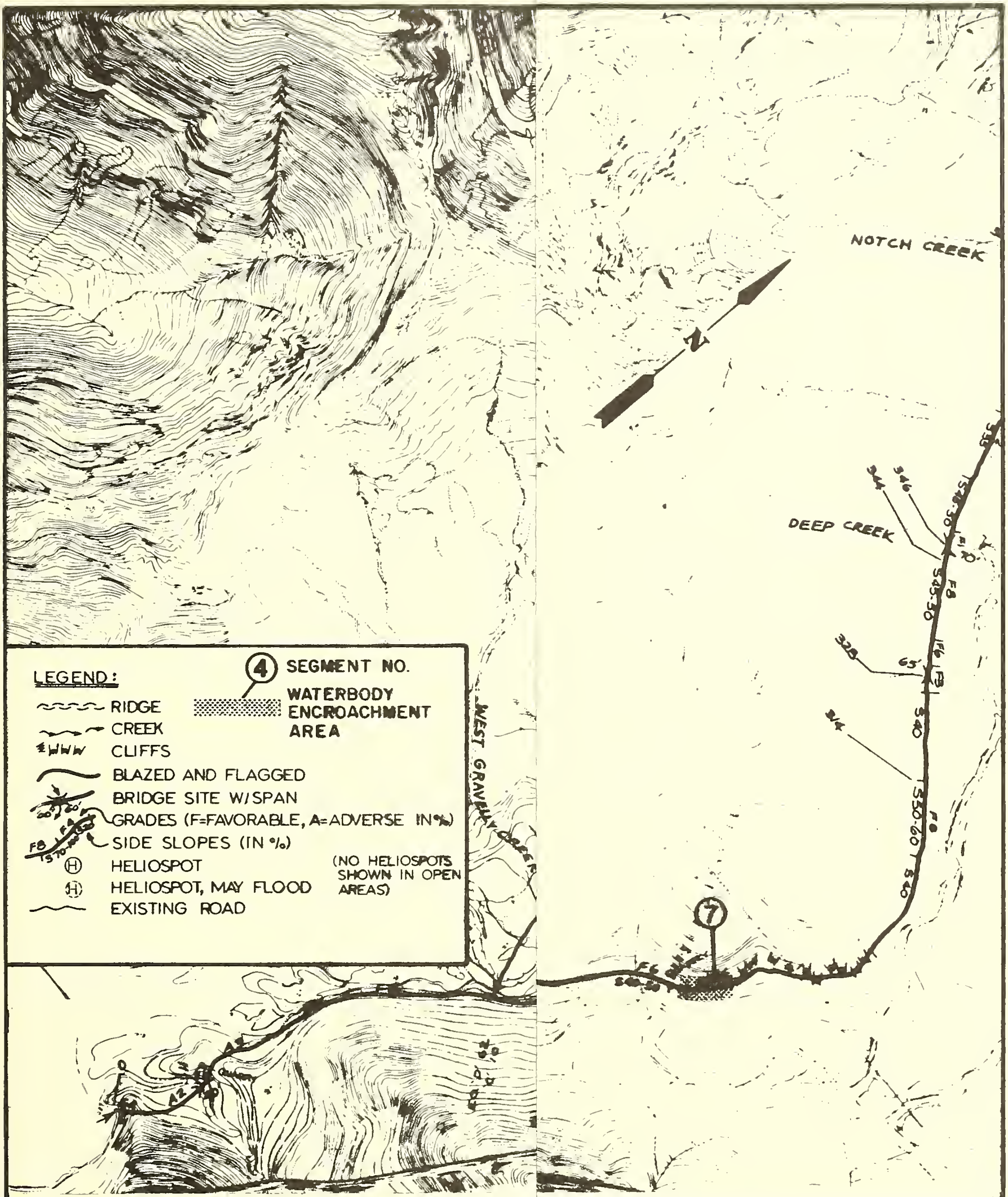
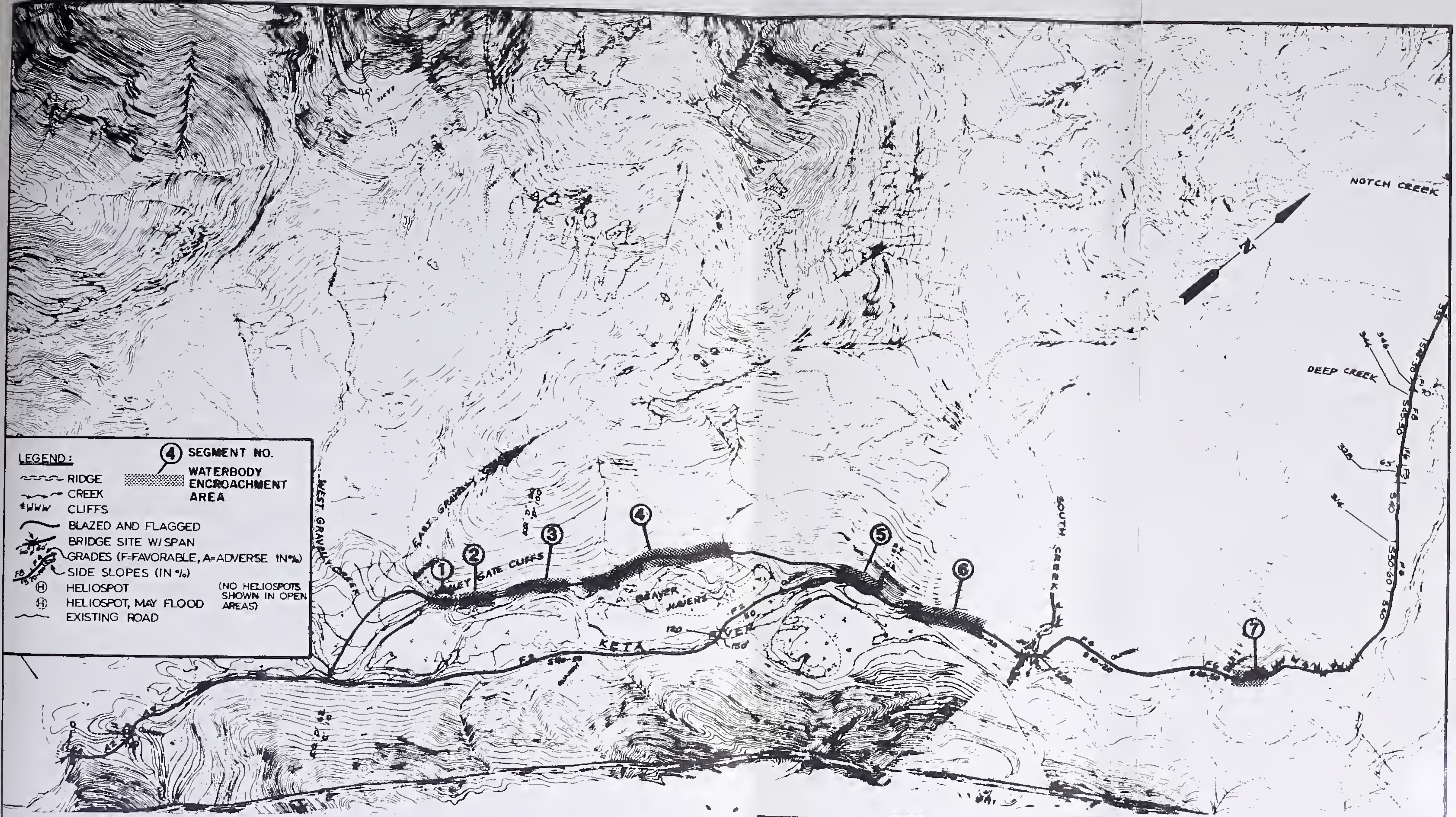
[1] Adjacent to or near = within 100 feet



ROADWAY ENCROACHMENTS
NTO OR NEAR WATERBODIES
THE KETA RIVER FLOODPLAIN

: U.S. Forest Service

Figure 4-6



QUARTZ HILL PROJECT
ROAD ACCESS AND BULK SAMPLING EIS

ROADWAY ENCROACHMENTS ONTO OR NEAR WATERBODIES IN THE KETA RIVER FLOODPLAIN

Source: U.S. Forest Service

Figure 4-6

Encroachment area No. 5 consists of 65 meters (210 feet) of roadway immediately adjacent to the main channel, 75 meters (250 feet) of roadway in a tributary stream and another 45 meters (150 feet) of roadway along side the tributary stream.

At encroachment area No. 6, the roadway would be in the main channel for a length of about 120 meters (400 feet) reducing the channel width by 3 to 5 meters (10 to 15 feet). Riprap would be required at this location. Immediately upstream of area No. 2, the roadway would traverse a wetland containing several small streams for about 250 meters (820 feet). In one location, a channel would have to be constructed to maintain water flow through the area. Several culverts would also be needed. Impacts on small waterbodies resulting from the access road would probably be greatest in this area.

At encroachment area No. 7, about 80 meters (720 feet) of roadway would skirt the edge of several ponds directly encroaching on the ponds for a width of 3 to 5 meters (10 to 15 feet).

The optional Keta road route would avoid some of the encroachment areas (No's. 1 through 4) but would probably involve other areas of encroachment. Hydrological impact would probably be somewhat less with the optional route. Detailed analysis is not possible since the optional corridor has not been surveyed.

Hydrological Impact - Substantial hydrological impact could result at two locations described above (encroachment areas 1 and 5 from Figure 4-6) where the roadway restricts main Keta River flow. A scour condition would be created causing the river to alter its channel within the floodplain to adjust for the lost channel area. This adjustment would be a short-term condition. The Keta River beds and bars are of gravels and rubble and natural channelization and deposition is very evident and occurs every year. Rechannelization caused by encroachment would probably be nearly completed in one year. However, if the river was constricted by more than about 30 percent, readjustment could require several years. The largest percentage of rechannelization would be accomplished during peak flow periods from May to

June and in October. The floodplain is not constrained at either encroachment location; therefore, the new channel would probably have similar characteristics of gradient, water velocity, and substrate composition. This would be especially true if the river were intentionally rechannelled and if the new channel had the same length as the old. Intentional rechannelization would also reduce the time required to reach a new hydraulic equilibrium.

The flood frequency data presented in Table 3-3, physical characteristics of the Keta River floodplain, and the presence of large trees adjacent to the river suggest that the Keta River is not subjected to extreme flood conditions. The bulk sample roadway would be constructed above the 100-year flood stage and, therefore, river flow would not be expected to wash over the road. The river flow would, however, wash against the road embankment at encroachment areas 1 and 6 during normal flows and at high flow would wash against the road embankment at encroachment areas 1, 2, 3, 5 and 6. All these roadway segments would require embankment armoring (riprap) to prevent erosion of the road fill.

Transverse crossings of streams would not be expected to change the hydrologic characteristics along the Keta Route. However, inadequate engineering design and/or poor construction techniques would likely create problems with scour or ponding. Ponding, if it was a significant volume, would moderate the peaks and valleys of the hydrograph below the stream crossing. Scour is unlikely to create significant problems because most streams are in deep valleys and cannot develop new channels. Exceptions along the Keta route include the bridge crossings at Keta River and Smith (Back) Creek. Smith Creek, near the route, has an unstable channel and evidence of additional channels. Proper engineering and construction of the crossings of the Keta River and Smith Creek would mitigate adverse hydrologic effects.

Water flowing over bare rock in areas of landslides along cliffs would be intercepted by the waste pile at the toe of the slope. Initially, water would flow over and through the waste pile as sheet flow. Channelization through the waste pile would eventually occur if the volume of water is large enough. The potential for channelization to extend from a waste pile to an existing stream depends upon distance, gradient, soil type, vegetation, and the elevation of the groundwater table. Although the probability for mass failure along the Keta route is low, the probability of channelization reaching the Keta River or Hill Creek is high because of the relatively short distance between the route and the streams and because there is no flat buffer zone along Hill Creek. The stream impact model to be completed for the final EIS will consider the probability of channelization and the effectiveness of intervening terrain in preventing channelled flow.

Roadway cuts typically intercept groundwater flows and convert the flow to overland flow. This flow would be directed into the roadway drainage system, and the types and magnitude of potential impacts would be directly related to the adequacy of the drainage system. Such flows begin, reach a peak, and recede within a short period and would likely occur only during large rain storms and snowmelt.

4.3.1.4 Water Quality

Because of the central importance of the water quality issue as related to impacts on fish resources, two different approaches have been used in considering water quality impacts. This section discusses impacts qualitatively with impact assessment based on professional judgement. The stream impact modelling study to be completed for the final EIS will provide a quantification of impacts resulting from sediment transport and deposition.

Construction of the marine facilities in Boca de Quadra would result in a short-term increase in sediment and turbidity in the water adjacent to the construction activity. Nutrient concentrations may exhibit a temporary increase, but other water quality characteristics are not expected to display any significant changes due to construction activity.

Much of the discussion pertaining to potential water quality impacts resulting from road construction on the Blossom route also applies to the

Keta route and is not repeated here. The pertinent differences, however, are presented.

The probability of construction generated mass soil movements is about five times lower for the Keta route as compared to the Blossom route. However, if mass soil movements do occur, they may directly affect the Keta River or Hill Creek because of the relatively short distance between the route and these streams. The soil movement analysis in Table 4-4 suggests that substantial quantities of soil material would enter Hill Creek and the Keta River during the year following initiation of road construction. Some of this sediment would be carried through the river system and deposited in Boca de Quadra, while a portion would be deposited throughout the length of the Keta River below the points of sediment input. The stream impact modelling study in progress will help to define the amounts and location of deposited material. The greatest amount of deposition would occur during low flow periods and in low velocity stream reaches. Most deposited material would be washed from the stream bottom during subsequent high flow periods.

Surface erosion may impact the Keta River on a long-term basis because much of the route between the Keta River crossing and Hill Creek lies in the Keta River floodplain. The magnitude of water quality impacts, primarily increases in sediment and turbidity, would depend on the frequency with which floods encroach on the roadway embankment. Impacts may be serious and persistent if the 2 or 5-year flood stages are high enough to reach the embankment. This situation could create scour conditions leading to channel erosion or rechannelization. The magnitude of impact would be significantly reduced if these conditions only occurred with the 50 or 100-year floods.

Estimates of potential sediment input are rough and actual amounts could vary substantially from those presented in Table 4-4. Nevertheless, it appears that short-term increases in suspended sediment concentrations would be significant within the Keta River. It is expected that the majority of sediment transport would occur during the year following construction with decreasing amounts thereafter.

Based on existing water quality data and the soil movement analysis in Table 4-4, it is estimated that the annual sediment load within the Keta River would be increased by about 230 percent during the year following initiation of road construction.

Natural Sediment Load	3,261 tons/yr.
Construction-Induced Load	
Landslides	4,163 tons/yr.
Sheet Erosion	75 tons/yr.
Total	7,499 tons/yr.

Potential sediment input to the Keta River as a result of road construction has been estimated to be about 20 percent of that which could be deposited in the Blossom River as a result of Blossom road construction. Also, the average gradient of the Keta River is 0.5 percent as opposed to 0.1 percent for the Blossom River. Therefore, construction induced sediment deposition would be substantially less in the Keta River.

Water quality impacts resulting from the Quartz Hill mineral exploration activities would be identical to those discussed for the Blossom access in Section 4.2.1.4.

4.3.2 Effects on the Biological Environment

4.3.2.1 Wildlife and Terrestrial Habitats

Surface areas of the various habitat types directly altered by the proposed Keta River access road and other facilities are expressed in Table 4-6. Approximately 16.1 hectares (40 acres) would be lost to production during the life of the roadway and for an indefinite period thereafter. An additional 28.5 hectares (70.7 acres) within the road right-of-way would be disturbed by clearing, causing a probable decrease in productivity. Additional loss of productivity would occur as a result of landslides in steeper areas. Approximately 10 percent of the Keta River access route is on terrain susceptible to such sliding. Up to 4 hectares (9 acres) of additional terrain could be altered by landslides based on Table 4-4.

TABLE 4-6

QUANTITIES OF TERRESTRIAL HABITAT ALTERED BY THE KETA RIVER ACCESS ROAD, MARINE FACILITIES, AND MINERAL EXPLORATION FACILITIES

			Surface Area (hectares [acres])		
	Habitat Type	Linear Distance (m [ft])	Filled or Cut Area(1)	Additional Cleared(2)	Total
ACCESS ROAD	Mature coastal spruce/hemlock forest-adjacent to Boca de Quadra	1,630 (5,350)	1.3 (3.2)	2.5 (6.1)	3.8 (9.3)
	Keta River floodplain-mixed well-drained spruce/hemlock, deciduous forest, riparian shrub-highly divese	6,477 (21,250)	5.1 (12.7)	9.8 (24.4)	14.9 (37.1)
	Sideslope forest- poorly-drained hemlock/cedar with shrubby avalanche chutes-Hill Creek valley	5,563 (18,250)	4.4 (10.9)	8.5 (20.9)	12.9 (31.8)
	Wetlands				
	Estuarine Marsh	425 (1,400)	0.3 (.8)	0.6 (1.6)	0.9 (2.4)
	Forest Edge-poorly-drained hemlock/cedar mixed with muskeg-White Creek Valley	2,057 (6,750)	1.6 (4.0)	3.1 (7.7)	4.7 (11.7)
MARINE FACILITIES	Mature coastal spruce/hemlock forest - adjacent to Boca de Quadra		1.0 (2.5)	0.4 (1.0)	1.4 (3.5)
MINERAL EXPLORATION FACILITIES	Wetland				
	Mixed non-forested and forested muskeg		2.4 (5.9)	3.6 (9.0)	6.0 (14.9)
	Total Wetlands		4.3 (10.7)	7.3 (18.3)	11.6 (29.0)
	Total		16.1 (40.0)	28.5 (70.7)	44.6 (110.7)

(1) Based on a corridor 7.9 meters (26 feet) wide for the access road (4.2-meter [14-foot] driving surface, 0.9 meters (3 feet) of fill and 2:1 embankment slope). Actual width of disturbed areas would vary depending on depth of fill and/or height of cut slope.

(2) Based on 7.6-meter (25-foot) clearing width on both sides of roadway or pad.

Impacts to terrestrial habitats resulting from the optional Keta River road route on the southeast side of the floodplain would be essentially identical to primary route impacts.

The road passes through five major habitat zones: mature coastal forest adjacent to Boca de Quadra, estuarine marsh, forested Keta River floodplain, forested sideslope along Hill Creek, and mixed forest and muskeg in the White Creek valley. Of these habitat zones, the estuarine marsh probably has the greatest value to wildlife, followed by the Keta floodplain. Overall, habitats disturbed as a result of the Keta River access road would probably be somewhat more valuable than those disturbed by the Blossom River access road. However, in view of the undisturbed nature of the surrounding terrain, it is unlikely that direct habitat withdrawal alone would impact regional wildlife population levels significantly. Some local displacement of animal species could occur.

Disturbance resulting from noise and construction activity would probably be substantially greater at least over the short term than that resulting from direct habitat alteration because of the much larger impact zone. The intense noise levels generated during the construction period would cause many mobile animals, particularly birds and larger mammals to abandon or avoid areas of high disturbance. Blasting requirements for the Keta River access route would be considerably less than those for the Blossom River route. Primary blasting areas would be at the marshalling area, at the bluff just north of the marshalling area, at the "Valley Gate Cliffs" (Figure 2-14), and where the road turns the corner from the Keta floodplain into the Hill Creek valley.

Waterfowl associated with the estuarine marsh at the head of Boca de Quadra would be particularly vulnerable to disturbance. Blasting near Aronitz Creek and at "Valley Gate Cliffs" as well as bridge construction across the Keta River would cause considerable disturbance to the marsh and could decrease waterfowl use and nesting success on part or all of the marsh area during the construction period. Construction would probably occupy 2 years; therefore, waterfowl use could decrease for both 1982 and 1983.

Two bald eagle nests are located within the potential zone of impact. Both are near the mouth of Aronitz Creek and would be relatively close to the proposed road but the road would probably be outside the required 100-meter (330-foot) buffer zone. Neither nest was thought to be active in 1980 (VTN 1980d). However, if either nest becomes active, construction disturbance could cause abandonment of the nest, especially if the disturbance occurs prior to egg laying. Eagles concentrate in the Keta estuary in late summer and fall presumably to feed on spawning salmon. Disturbance during this time could interfere with feeding habits.

The reaction of brown and black bears to construction disturbance varies according to individual animals. While some bears might abandon construction areas, the trans-Alaska pipeline experience suggests that the net effect would probably be attraction of bears to construction areas because of the availability of food (Milke 1977). Some bears would probably become a nuisance and have to be killed while others could become dependent on artificial food sources, resulting in a reduced ability to survive. Proper disposal of waste and prevention of animal feeding by workers would minimize this problem.

Mountain goats appear to be relatively susceptible to disturbance impacts (Singer 1975). However, goats would be unlikely to be concentrated near construction areas. Goats inhabititing the ridge tops adjacent to the Keta River valley (Figure 3-2) could be close enough to be affected by blasting noise. These animals might move to adjacent ridges or slopes not facing the Keta valley.

The roadway both during and after construction would be likely to alter animal movement patterns. Bears and wolves would use the road as a travel corridor during times of minimal road use. Cut slope portions of the road could block movements perpendicular to the road. Most of the Keta River route is at the base of a very steep side slope. Animal movements across the road would not be expected to be exceptionally common except where the road crosses the Keta River and its floodplain adjacent to the estuarine marsh. Animals moving down the river valley toward the marsh would have to cross the road. This would be expected to be a major movement zone for bears and possibly other mammals. Movements of bears and mountain goats across the road probably would not be significantly affected during periods of no human disturbance. However, if vehicles are present or other activities are in progress, bear and particularly mountain goat movements could be hampered significantly (Singer 1975).

Perhaps the most serious impact to game animals such as goats and bears would result from the increased hunter access to high altitude areas. Hunting would be concentrated in the vicinity of the roadway and adjacent goat and bear populations would probably decrease (Pendergast and Bindernagel 1977).

4.3.2.2 Wetlands

Of the total area directly altered by the Keta River access road, marine facilities and ore sampling facilities, 11.6 hectares (29 acres) or 26 percent is classified as wetlands according to the criteria presented in Section 3.3.5. In addition to direct impacts, wetland structure and function could be altered by blockage of natural drainage patterns and disturbance of wetland inhabitants. General wetland-related impacts on vegetation and wildlife are presented in Section 4.3.2.1. The following paragraphs address wetland impacts in relation to the special values presented in Section 3.3.5.

Some plant and animal productivity would be lost. Muskeg type wetlands are not especially productive and are widely dispersed throughout the area. Therefore, impacts resulting from loss of productivity would probably not be significant for this habitat type. About 1 percent of the surface area of the more valuable estuarine meadow at the Keta River mouth would be altered and animal use of the southeast margin of the estuary would be reduced, especially while the roadway is in use. These impacts could noticeably affect local productivity but probably would not be significant on a regional basis. Food webs would not be greatly interrupted. The possible alteration of juvenile salmon rearing habitat within the wetlands is discussed in Sections 4.3.2.3 and 4.3.2.4.

Wetland habitat available for wildlife use within the estuarine marsh and possibly along the muskeg/forest edge in the White Creek valley would be slightly reduced. Waterfowl use of the southeast margin of the Keta River delta would probably be affected during construction and periods of heavy road use.

Significant impacts on local hydrological regimes and nutrient chemistry would not be anticipated from the relatively small wetland encroachments proposed for the access road and other facilities. Cross drainage provisions along roadways would minimize such effects.

The access road and marine facilities would not be expected to adversely affect recreational opportunities on the Keta River delta over the long term. Access to potential hunting areas would be improved. The quality of such recreational experiences could, however, be reduced by the presence of man-made structures and possibly by the presence of noise and other disturbance factors.

4.3.2.3 Fish and Aquatic Habitats

The construction, operation and maintenance of an access road via the Keta River alignment could potentially cause both direct (local) and indirect (downstream) impacts to the fish and aquatic habitats.

The potential for direct impacts to fish habitats (other than sediment deposition) resulting from the Keta River access road would be greater than for the Blossom access. The road would cross seven creeks. Of these, Aronitz and Smith (Back) Creeks are known to support fish in the area of the proposed crossings. The preliminary access road route would also cross the Keta River and would encroach on the active Keta River channel in two locations (encroachment areas 1 and 6 from Table 4-5) for a distance of 146 and 122 meters (480 and 400 feet) respectively. The optional road route would only encroach on the Keta River at the latter location. Crossings of major fish streams would be bridged, resulting in little or no permanent impacts on river substrate or hydraulics.

The Keta River channel encroachments would involve filling into the active channel accompanied by rechannelization of the river flow. Rechannelization often results in a shorter stream reach with a higher gradient than the original and a consequent reduction in biological productivity. The river area that would be impacted at encroachment area No. 1 contains some of the more heavily used pink and chum salmon spawning habitat. During the peak of pink salmon spawning in 1980, VTN (1980b) observed about four salmon per lineal foot of stream. In a worst case, 146 meters (480 feet) of road encroachment on the channel could eliminate spawning area for about 12 percent of the total peak escapement. Downstream hydrological changes could alter additional spawning habitat. However, it would be unlikely that such a serious impact would occur. Instream work would occur at a time when adult salmon would not be present and, as a mitigation measure, the stream would be rechanneled to retain as closely as possible the length, gradient and substrate that now exists. Some decrease in spawning density and/or egg survival could occur during the first summer after rechannelization since the river would not have reached hydraulic equilibrium within the new channel, causing some scour and deposition to occur during high flow periods. It would be difficult to predict over the long term whether the new channel would support as many spawning salmon as the old channel. There is, however, no reason to believe that spawning would be greatly affected.

The second main channel encroachment area (No. 6 on Table 4-5) is less heavily used by spawning salmon. Less than one fish per lineal foot of stream or about 1 percent of the total escapement could be affected. Mitigation measures as described in the previous paragraph would minimize impacts.

The portion of the Keta access road upstream from "Valley Gate Cliffs" would also encroach on at least two sloughs of the Keta River and several interconnected ponds and wetlands (Table 4-5 and Figure 4-6), some of which have beaver activity. See Section 4.3.1.3 for detailed discussion. Up to 550 meters (1,800 feet) of roadway would encroach onto these slow moving waters. VTN (1980b) found chinook and/or coho salmon juveniles and chum salmon fry in the backwater area at encroachment area No. 2 and chum and coho salmon juveniles were observed in the ponds at encroachment area No. 7. Actual impacts on these areas would depend on the precise road route. All areas connected to the river would probably be used as rearing areas by salmonid fish. It is estimated that about 0.1 hectares (0.23 acres) of an approximate 20 hectares (50 acres) of potential slow water rearing habitat would be altered by the access road. These kinds of habitats would be difficult to duplicate through mitigation and some loss of rearing habitat would result.

An additional area of direct impact would be at the southeastern side of the Keta delta marsh area where the roadway would impinge on Keta River distributary channels that are used as rearing areas by coho salmon. This situation would be similar to that encountered by the Blossom access road but impacts would be less severe because less channel would be affected and fish use is probably not as great. See also the discussion in Section 4.3.2.4.

Another potential source of direct impact would be blasting. Blasting at the river's edge would probably occur at the "Valley Gate Cliffs" area and perhaps in the vicinity of Station 210+00. Blasting very close to the river (less than 15 meters [50 feet] away) during the early egg incubation stage (primarily mid-July through October) would have a high probability of reducing salmon egg survival (see Section 4.2.2.3). Blasting during the period April 1 - July 1 would probably have very little impact.

The optional Keta road route on the southeast side of the floodplain would probably have somewhat less direct impact on fish habitats because it would avoid the sensitive "Valley Gate Cliffs" area and other encroachments. However, some additional side channel encroachment would result.

Most of these encroachment activities would involve instream construction, resulting in disturbance of the stream bottom and increases in suspended sediments. The Alaska Department of Fish and Game has indicated that instream work in the Keta River should only occur during the period April 1 to July 1; therefore, impacts to adult spawners, incubating eggs and emerging fry would be minimized. The discussion in Section 4.2.2.3 of possible chronic impacts on fish due to construction induced transport of sediments and deposition on stream substrate is equally applicable to the Keta River access route. Sediment deposition on spawning gravels could cause both short and long-term reduction in the survival rate of incubating salmon eggs, thus reducing the overall productivity of Hill Creek and the Keta River. In the Keta River, 67 percent of pink salmon, 48 percent of chum salmon and 29 percent of chinook salmon spawned within the potential zone of impact (below Hill Creek) based on 1980 aerial surveys (VTN 1980b).

Whether or not short and long-term impacts resulting from sediment deposition would actually occur in the Keta River cannot be determined with certainty. As described in Section 4.3.1.4, suspended sediment load would increase substantially above natural levels during and after construction. Deposition of sediment would increase in the Keta River. Insight into the extent of this deposition will be provided by the stream impact modelling study now in progress. Some idea of impacts to fish can be acquired by repeating the analytical method used in Section 4.2.2.2 for the Blossom access route. A 230 percent increase in sediment, as suggested for the Keta River, during access road construction would increase the percentage of fine sediment in the gravels by an estimated 10 percent (Figure 4-2). Existing Keta River spawning gravels contain about 18 percent fine materials (Edgington 1979). Increasing this by 10 percent would reduce the percentage of salmon eggs that survive to emergence by 25 percent or more (Figure 4-3). Assuming that adult returns are proportional to fry numbers (which may or may not be true), Keta River pink salmon would be reduced by 17 percent, chum salmon by 12 percent and chinook salmon by 7 percent. Biomass of juvenile fish would probably also decrease; Figure 4-4 suggests that a 230 percent increase in sediment would reduce biomass by 55 percent. Most of the above impacts would be short term with primary effects occurring in 1982, 1983 and early 1984. Long-term impacts due to permanent alteration of substrate composition would be possible. The Keta River has a steeper gradient and greater scour capacity than the Blossom River. Therefore, long-term impacts from sedimentation would be less likely from Keta access road construction than from Blossom road construction.

Impacts to fish in the Keta River and Hill Creek could also occur as a result of water quality alterations originating from the exploration adits and other Quartz Hill activities. Such impacts would be unlikely because of the dilution factor and distance from fish use areas. Alterations to water quality in the Keta River have not occurred as a result of existing exploration activities which are similar to the proposed activities. In any event such impacts would be negligible when compared to the much greater disturbance caused by the access road.

In summary, a qualitative appraisal of the Keta River road corridor leads to the following conclusions:

1. Impacts to fish resulting from suspended or deposited sediments would, for the most part, be short term. Some reduction in 1982 and 1983 spawning success could occur in the Keta River. Some low level but long-term sediment transport would occur into the Keta River as a result of surface drainage from road surfaces.

2. Sediment deposition would probably not be sufficiently severe to cause a long-term loss in the productivity of spawning areas.

3. Substantial direct alterations of fish habitats would occur. Most of these impacts could be mitigated but some long-term loss of productivity would result, especially in regard to rearing habitat.

4. Temporary impact from sedimentation would be substantially less for the Keta access when compared to the Blossom access.

5. Approximately half as many salmon spawners use the Keta River impact zone as use the Blossom/Wilson impact zone. Therefore, a smaller fish resource is at risk from the Keta access road than from the Blossom access road under worst-case conditions (all fish present subject to impact). On the other hand, a greater proportion of the total Keta River salmon escapement inhabits the Keta impact zone than is the case for the Blossom impact zone. Therefore, on a percentage basis, Keta fish resources could be more greatly affected than Blossom fish resources.

4.3.2.4 Marine Habitats

Marine and estuarine habitats in the upper portions of Boca de Quadra would be directly affected by marine facility and road construction and indirectly by sedimentation that might wash from road cuts or fills along the estuary or be transported to it via the Keta River. As decribed for the Blossom access route (Section 4.2.2.4), impacts of marine facility construction and log rafting would be of no long-term significance to local productivity. Siltation from road and wharf construction along the estuary would be of short duration and have minimal effects.

Sediment transport to the estuary via the Keta River could increase substantially over natural background levels in the event a major slide occurred in the Hill Creek valley or due to necessary instream work along the Keta River. These sediments would settle to the bottom in areas where wave and current energies are no longer sufficient to maintain them in suspension. Since the same physical laws govern these sediments as govern naturally transported sediments, there should be little net change in grain size in the estuary. However, some local smothering of benthic fauna could occur if rates of deposition greatly exceed those naturally occurring during the season in question. Such losses of benthos would be short-term and of little significance to the health of the estuary.

The major impact of road construction on estuarine habitat would occur along the east shore of the estuary north and perhaps southeast of the Aronitz Creek mouth where steep cliffs would force the road onto the upper tideflats for a distance of about 425 meters (1,400 feet). Assuming a 15-meter (50-foot) band of disturbance in this area, up to 0.9 hectares (2.4 acres) of tidelands would be altered, about 1 percent of the approximately 80 hectares (200 acres) of tidelands on the delta. Major habitats affected would be the grass/herb zone above normal high water, the sedge/*Fucus* zone near normal high water levels, and a distributary channel of the Keta River flowing over a gravel bed. Lesser area of steeply sloped muddy sand sides of the channel would be affected, as well as some silty sand flats.

The grass/herb and sedge/Fucus zones are important producers of organic material that ultimately contribute to the marine productivity of the fjord. The distributary channel and associate banks and sand flats produce epibenthic zooplankton, primarily crustaceans, that are the primary food of outmigrating juvenile pink and chum salmon (e.g. Simenstad et al. 1980). In addition, the distributary channel contained low numbers of silver salmon fry when visited in June 1981 (J. Houghton, personal observation). These fish also depend upon locally produced food items and may well spend a longer period of time (summer and fall?) in the area than do the pink and chum outmigrants. Access road construction may result in closure of this channel and diversion of its flow through other channels. This would eliminate a significant proportion of the small channel habitat on the delta. Alternatively, the channel may be displaced to cut through what is now sedge/Fucus or grass/herb habitat. While this latter course of action would increase the loss of these higher ground habitats (perhaps to 1.5 percent of the total present), it would be far more desirable from a fisheries standpoint because it would retain the majority of the important small distributary stream habitat. It is expected that productivity of the relocated channel would be restored to near existing levels within 1 year of channel stabilization. Riprap placed to protect fill embankments would support a Fucus-barnacle dominated community similar to that on natural hard substrates at the same tide level.

Limited shipping and offloading of construction equipment and material at the marine facilities would have little significant impact on marine biota. Low-level releases of petroleum hydrocarbons from bilge pumping and deck or staging area runoff would be of little significance although low-level uptake by some benthic species might be measurable. A larger spill due to ship grounding, collision, or fuel-handling mishap would have more severe impacts, particularly if it were driven by wind or tide onto the shallow estuarine shelf at the mouth of the Keta River during the spring. These shallow areas may be of considerable importance to the early marine survival of some juvenile salmonids and to the rearing of others, especially pink and chum salmon, which use them for saltwater acclimation and for early marine feeding. If wave action worked the spilled oil into the soft intertidal sediments on the Keta delta, effects could persist for several years, perhaps reducing feeding opportunities for important fish species including juvenile salmonids. Birds and mammals could suffer severe impacts. The steep rocky cliffs of the littoral zone would have a moderate vulnerability to spilled oil (Gundlach et al. 1980) but would probably recover relatively rapidly. The probability of a shipping accident in transit would be low because of the limited number of vessel visits during this phase of project development.

4.3.2.5 Threatened and Endangered Species

No impacts to threatened or endangered species are anticipated.

4.3.3 Effects on National Monument Management Values

The impacts from bulk sampling and construction of the access road would largely be limited to the portion of the Monument that has been identified as available, subject to conditions of ANILCA, for development of the Quartz Hill deposit. Impacts would be felt in the rest of the Monument but they would be minor compared to effects that would occur during full mine development.

4.3.3.1 Primitive Recreation Experience

The existing level of use of the Boca de Quadra area is low in relation to most of the Monument. This use is of a primitive nature due to access and the fact that little impact by man has occurred on adjacent lands. Presence of the construction camp and marine facilities, road construction and associated support activities would eliminate the primitive nature of the area. The small amount of recreational use by personnel involved in the construction phase would have only minor impacts in comparison to those of a townsite in the same area (see additional discussion in the CAD). Impacts would be less significant on the existing primitive recreation experience available in Boca de Quadra than in Smeaton Bay/Wilson Arm due to the low existing or projected use.

4.3.3.2 Ecological Values

Ecological values would be impacted to the extent that road construction and placement of facilities would impact the physical resource. The Keta route has potential for up to 4 hectares (10 acres) of landslides that could to some degree affect the Keta River system. The Keta route would have some additional effect due to the encroachment on the Keta River for a considerable distance. The less steep slopes would permit overlay road construction over much of the road, which would create less physical disturbance than construction on the Blossom route. The effects of this disturbance on other resources is evaluated in other portions of the EIS.

4.3.3.3 Effects on Cultural, Historic and Prehistorical Values

Adverse effects on cultural resources as a result of access road construction and bulk sampling activities are considered to be unlikely or minimal. The archaeological survey conducted by Ackerman and Gallison (1981) found one site (No. 19) near the Keta River access road at the mouth of Aronitz Creek that they felt would require additional exploration. The road as now designed would avoid the site and no impact would be expected. The survey was of limited scope, however, and other sites may exist. It is not believed that significant cultural resources exist to the extent that road or mine development would be precluded. However, an archaeological survey employing subsurface testing of the proposed route as recommended in the CAD should be undertaken before actual construction begins. Standard archaeological practice would be followed in the event cultural material is found.

4.3.3.4 Aesthetic Values

See Appendix D for a detailed analysis. As is the case for the Blossom River access, the Keta River access road along Boca de Quadra and the proposed marine facilities would be highly visible to marine travellers and constitute a major modification to the natural landscape. The road segment along the tide flats would be viewed obliquely and, thus, would not be highly visible from all locations on Boca de Quadra. The road segment between the marshalling area and Aronitz Creek would, however, be highly visible.

The roadway in the Keta River floodplain and along the Hill Creek valley would be visible from the air. This air corridor is not often used by recreational air travellers.

Visual impacts resulting from the Keta River access route would be significantly less than would occur with the Blossom River access. Overall scenic quality is somewhat less and marine and air traffic occurs with less frequency.

4.3.4 Effects on Wilderness Values

The adjacent Wilderness would be somewhat affected by the access road construction. The impact would be much less than the impact in the future if the access road dictates mine development access. The location of a townsite in Boca de Quadra would have less cumulative impact on wilderness values as discussed in Section 2.3.4.8.

The most significant effect of the access road construction and the bulk sampling process will be diminishment of the quality of wilderness experience. There are no developed recreation sites close to the Keta drainage. The noise associated with the construction and operation would detract from the high quality wilderness solitide. This would be less significant here than in the Blossom access alternative due to low amount of use in the area. Noise may be somewhat noticeable in heavily used portions of the Monument.

Air traffic associated with support activities would continue to detract from wilderness solitude.

Boca de Quadra, due to its remoteness and less desirable access does not, and is not predicted to, receive significant recreation use. Therefore, conflict with use would be low. Boca de Quadra is less accessible to the most heavily used and spectacular portion of the Wilderness and its use for mine access would create fewer management impacts that could threaten wilderness values than would access via the Blossom route.

There would be little impact of access via the Keta River on the existing very low level of hunting, fishing, and trapping in the area except that success of hunting in the area would be substantially reduced during the 2-year construction period.

4.3.5 Noise

Noise from blasting and heavy equipment use would disrupt large mammal and bird activities within nearby parts of the exclusion area. Some blasting noise might be audible in designated Wilderness portions of the Monument. Increased air and boat traffic to and from the site would add substantially to existing very low levels of noise in the Wilderness area adjacent to Boca de Quadra.

4.3.6 Economic Effects

Economic effects related solely to the access road and bulk sampling activity would primarily involve the Ketchikan area. Direct local economic effects would include 100 new jobs for the 1- to 2-year construction period. The work force for road construction and bulk sampling would include truck drivers and heavy equipment operators, drillers, powdermen, foremen, time keepers, loggers, shopmen, and pilots. A portion of the work force could be filled by local workers. Income for Ketchikan businesses would also be generated, related to services and supplies such as air charter services, groceries, and other supplies for the Quartz Hill operation. There would also be economic benefits for businesses in Ketchikan providing transportation and entertainment services for off-shift workers. The actual percentage of the workers who would spend off-shift time in Ketchikan as opposed other destinations is not known, nor is the dollar amount of possible expenditures per worker. It is expected that off-shift time, and therefore economic impacts to Ketchikan businesses would be relatively small due to the brief periods of leisure time available to workers.

An additional minor benefit would be the income generated by timber sales in Ketchikan, which would occur as a result of access road logging. A portion of the cut timber would be retained on site for construction purposes, so the actual value represented by this potential economic activity is not known.

4.3.7 Social Effects

Social effects related directly to the access road construction and bulk sampling activities would be relatively minor, due to the small size of the work force involved, the work schedule, and the remoteness of the location. The activities involved would be similar to any other logging and road building operation of a comparable magnitude in southeast Alaska. It is expected that the majority of the work crew would be experienced in similar projects and would be prepared for the stresses of a rigorous work schedule at an isolated site. Negative impacts to Ketchikan are expected to be minor, and may involve temporary incidents such as disorderly conduct, or similar effects associated with a crew visiting from a remote site. Again, because of the small size of the work force involved, and the relatively small amount of leisure time available, these problems are expected to be negligible.

It is not expected that a significant percentage of the workers would be married and relocate their families to Ketchikan, based on experience at similar projects. However, at this point, it is not possible to more precisely identify the percentage of married and single workers, or the number of families which might relocate to Ketchikan for the 1- to 2-year duration of this phase of the project.

Welfare or unemployment problems identified as potential problems for mine development in the CAD would not present a significant problem for the bulk sampling phase.

4.3.8 Hazard Susceptibility

The Keta bulk sampling roadway would be severely affected by avalanches. Studies (Appendix C) have indicated that there are six active avalanche tracks on the west side of the Hill Creek valley that cross the planned alignment. These avalanches are virtually certain to affect the bulk sampling roadway, particularly temporary bridge crossings of Deep Creek, Notch Creek, and other creeks in this area. The Deep Creek valley (which is also a major avalanche track) is a particular hazard. It is expected that the temporary bridge crossing of Deep Creek would be seasonally removed to prevent destruction by avalanches during the winter.

There is also a real possibility that landslides could affect the roadway. It is expected that most of the shallow slides that would develop as a result of the construction would occur downhill from the alignment. However, it is possible that some slides would occur uphill from the alignment since the roadway cut would remove support from the soil materials above. Such slides would most likely occur relatively soon after construction in response to severe rain and wind storms. Their effect would be to fill or partially fill the road prism with debris, which would need to be removed to restore service. Since the Keta route traverses much less steep terrain the Blossom route, landslide hazards would be proportionately less.

Aside from the avalanche hazards in the Hill Creek valley, it is possible that low-level temporary bridges could be affected by floods or debris flows along the creeks. This is especially likely at Back Creek where there is evidence of frequent channel changes as a result of debris floods emerging from the mountain front. It is also possible that drainage could accumulate on the uphill side of embankment or cut areas, either from natural sources or from blocked culverts, and flow down and across the road leading to erosion of embankment areas. This occurrence is considered unlikely if careful attention is paid to cross drainage provisions throughout the project.

Human safety hazards from avalanches would be minimal because the road would not be used during the snow season. Safety hazards from blasting would be minimized by good construction procedures. Hazard would be less for the Keta route than for the Blossom route because less blasting would be required.

4.3.9 Relationship Between Local Short-Term Use of the Environment and Maintenance and Enhancement of Long-Term Productivity

Granting a permit for the proposed short-term use for access road construction and bulk sampling will have one major impact on long-term productivity of this area: the likelihood that this action will lead to the full-scale development of the deposit. Such a development would significantly increase the long-term world production of molybdenum. Full mine development would, in turn, have two primary long-term impacts on natural productivity in the area. These are: 1) destruction of substantial additional acreage of terrestrial habitat, and 2) destruction of a large portion of the existing benthic habitat in Boca de Quadra and replacement with a tailings substrate (assuming marine disposal of tailings). This latter effect could result in long-term local reductions of numbers of some species of fish and shellfish that are harvested commercially here or elsewhere in southeast Alaska. The possible long-term impacts of mine development are discussed further in the CAD and will be addressed in greater depth in the mine development EIS.

The proposed road construction and bulk sampling would remove relatively small amounts of several local habitat types from long-term productivity. With intensive revegetation efforts, areas of disturbed soil could be restored to active production although the nature of reestablished communities would differ from the existing natural communities, which include old growth forests with trees several hundred years old. Areas of steep cut rock could not be revegetated but they would eventually support growths of ferns and mosses similar to those on natural cliffs. Scars from required cuts and fills would be visible from the water and the air for many years and would detract from the existing natural scenery of the area.

Siltation effects from road construction and from construction-caused slides are not expected to affect long-term productivity of fish populations. However, placement of fill within the Keta River channel could lead to a readjustment of the river channel downstream that could alter, to some degree, the long-term productivity of the area for salmon and trout.

4.3.10 Irreversible and Irretrievable Impacts

Access road and bulk sampling will have the following irreversible and/or irretrievable impacts:

1. Loss of the existing natural character of the area due to cuts and fills for the marine marshalling area, the road, and the adit work pads as well as spoiling of unused rock excavated from the adits. This effect would be largely irreversible and irretrievable.

2. Loss of terrestrial habitat in the marshalling area, road, construction work areas and adit work areas would be partially irreversible. Loss of productivity during a recovery period would be irretrievable.

3. Loss of 0.65 ha (1.6 acres) of tideland habitat would be irreversible and irretrievable.

4. Loss of energy expended in road construction and bulk sampling would be irretrievable.

5. Loss of fish production that might occur as a result of temporary siltation or rechannelization of the Keta River would not be irreversible; however, the opportunity to harvest these fish would be irretrievably lost.

6. Reduction in recreational, hunting, or fishing opportunities during the construction season would be an irretrievable loss.

7. Reduced reproductive success of bald eagles, waterfowl or large mammals during the construction period would be irretrievable.

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Our mailing list also contains about 450 individuals interested in the project, including members of Congress who worked on ANILCA. The list above was current in late October 1981, and will probably be added to before publication date.

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